WATER PLANT OPTIMIZATION STUDY

SAULT STE. MARIE WATER SUPPLY

DECEMBER 1993

Ontario

Ministry of
Environment
and Energy

ISBN 0-7729-3290-5

WATER PLANT OPTIMIZATION STUDY

SAULT STE. MARIE WATER SUPPLY

DECEMBER 1993

Cette publication technique
n'est disponible qu'en anglais.

PIBS 2798

Study Conducted By:

R.J. Holme, J.J. Gemin and S. Wyse
of
Proctor & Redfern Limited

Under the Direction of the
Sault Ste. Marie Project Committee:

Gary Martin - MOEE Water Resources Branch
Cliff Ireland - Sault Ste. Marie Public Utilities Commission
Ken Wallenius - Sault Ste. Marie Public Utilities Commission
Tom Godfrey - Sault Ste. Marie Public Utilities Commission
Frank Tesolin - MOEE Northeastern Region
John Wesno - MOEE Sault Ste. Marie District Office
Bill Gregson - MOEE Project Engineering Branch
Janusz Budziakowski - MOEE Approvals Branch
Gerry Sigal - R.V. Anderson Associates Ltd.

Address all correspondence to:

Ministry of Environment and Energy
Water Resources Branch
40 St. Clair Ave. West, 14th Floor
Toronto, Ontario
M4V-1M2

Please note that some of the recommendations contained in this report may have already been completed at time of publication. For more information, please contact the local municipality, or the Water Resources Branch of the Ministry of Environment and Energy.

Note, all references to Ministry of the Environment in this report should read Ministry of Environment and Energy.

WATER PLANT OPTIMIZATION STUDY
SAULT STE. MARIE WATER SUPPLIES

SUMMARY OF FINDINGS AND RECOMMENDATIONS

The optimization study for the Sault Ste. Marie Water Treatment Plant and groundwater supplies is the start of an ongoing documentation of the operation of the plant and wells. The study is a review of present conditions with emphasis on determining an optimum treatment strategy for removal of particulate matter and improving the disinfection processes. Outlined below is a summary of some of the findings and recommendations of this study.

1. Study the use of alternative coagulants such as polyaluminum chloride, including their effect on aluminum residuals.

2. Installation of a streaming current monitor and control equipment to control coagulant dosages.

3. Removal of dead areas in flocculators and filter channels.

4. More accurate means of calibrating and correlating turbidimeters.

5. Media depth and gradation should be monitored regularly.

6 Improve method of recording coagulant usage.

7. Revise methods of recording and reporting data to allow for quicker identification of problems and trends.

8. Improve the monitoring of chlorine residuals from the well supplies.

9. Maintain the frequency of bacteriological sampling from the distribution system in accordance with the Ontario Drinking Water Objectives.

Overall, the water quality from both sources in Sault Ste. Marie is very good. The treatment plant consistently produces water with a turbidity of 0.1 NTU and Total Trihalomethanes less than 0.02 mg/l.

Following commissioning of the new water treatment plant in 1986, the new central computer has permitted comprehensive record keeping of all plant and well supply data, and this system must be maintained.

INTRODUCTION AND TERMS OF REFERENCE

The Ontario Ministry of the Environment has undertaken Water Plant Optimization Studies at a number of locations. The purpose as stated in the Terms of Reference is to document and review present conditions, and determine an optimum treatment strategy for contaminant removal at the plant, with emphasis on particulate materials and disinfection processes.

The Water Plant Optimization Studies are also being co-ordinated with the Ministry of the Environment's Drinking Water Surveillance Program (DSWP), since a plant process evaluation is required for each plant entering the program. DWSP provides a continuously updated base of information on water plants and water quality.

For Sault Ste. Marie, the optimization study has two components covering the two different water sources being used in the City. These are a groundwater supply that has been in use for many years, and a surface water source (Lake Superior) that is treated at a newly constructed water treatment plant.

This study shows that both sources produce water that meets or betters the Ontario Drinking Water Objectives, and particularly that the new water treatment plant is capable of consistently producing water with turbidities in the 0.1 NTU range.

The study has been undertaken in accordance with the Terms of Reference attached to this report as Appendix D.

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

SECTION A - RAW WATER SOURCE

SECTION A RAW WATER SOURCE

A.1 SOURCES

The existing Sault Ste. Marie water supply consists of:

- groundwater delivered by four well pumping stations (incorporating 6 wells).
- surface water from Lake Superior to a newly constructed water treatment plant.

The groundwater is supplied by four well pumping stations, consisting of:

2 wells at Lorna Drive Pumping Station	(East End)
1 well at Shannon Drive Pumping Station	(East End)
1 well at Steelton Drive Pumping Station	(West End)
2 wells at Goulais Avenue Pumping Station	(West End)

The Lake Superior raw water intake is located at Gros Cap approximately 10,800 m from the water treatment plant location. The 1,200 mm diameter intake is 900 m from shore in 15 m of water.

The location of all system components are shown in Figure 9.

A.2 QUALITY

A.2.1 PHYSICAL PARAMETERS

a) Surface Water

The Gros Cap Water Treatment Plant went into operation in March 1986, less than twelve months prior to the completion of this study. Our analysis, therefore, is based upon a narrow database. From routine sampling data not reflected in

the Tables in this report, the turbidity of the Lake Superior surface water at Gros Cap itself, fluctuated between 0.25 and 2.5 FTU, while colour varied between 0.5 and 2.5 TCU. The remarks associated with the reports on these two parameters frequently denote "This Low Measurement Is Tentative, For Info Only" suggesting in part that the colour and turbidity levels were below accurately reportable levels. Temperatures have been reported in the 0 to 22°C range.

It is also noted that the surface water quality does vary from the raw water pumping station at Gros Cap to the influent works at the new water treatment plant. This appears to be due to the physical makeup of the raw water system (ie. 10,800 m of 750 mm raw water main and approximately 4,400 m^3 of storage at the Marshal Drive tanks.), although slight differences will also exist between turbidimeters.

No seasonal variations in surface water quality were discernible from the existing database.

b) <u>Groundwater</u>

Water quality data in terms of turbidity and colour is not plentiful. From available data, turbidity ranged between 0.02 to 0.38 FTU, while colour varied between 0.5 and 6.6 TCU. Groundwater temperature was generally 8°C with little variation.

A.2.2 GENERAL CHEMISTRY

a) <u>Surface Water</u>

The hardness levels of the surface water normally fluctuated between 42 and 46 mg/L (as $CaCO3$). The Alkalinity range during the study period was 64 mg/l to 78 mg/l. The pH of the raw surface water varied between 7.7 and 8.7, with more recent values more consistently in the 7.9 to 8.0 range.

b) <u>Groundwater</u>

The quality of groundwater varies between aquifers in the east and west parts of the City. The groundwater in the west end (Steelton and Goulais) is not as hard as water delivered in the east end. These wells (Shannon and Lorna) have hardness in the 70 to 120 mg/L (as CaCO3) range, while the Steelton and Goulais supplies vary between 60 to 70 mg/L (as CaCO3). The east end wells have alkalinity levels of 50.0 to 56.0 mg/L (as $CaCO_3$) and pH of 7.9 to 8.1. The west end wells have alkalinity levels of 90 to 103 mg/L (as $CaCO_3$) and pH of 8.3 to 8.5.

A.2.3 BACTERIOLOGICAL PARAMETERS

a) <u>Surface Water</u>

The raw water from Lake Superior is sampled approximately three times per day for both Total and Fecal Coliforms. The results are listed in Table 6.0. Total Coliforms have been detected throughout the years, however, in the period June through December they can be detected on a routine basis. Total Coliform counts, when positive, are generally less than 5 and never exceed 100 per 100 ml sample. Positive Fecal Coliform counts occur in approximately one quarter of the samples during July and August and are always less than 5 per 100 ml sample.

b) <u>Groundwater</u>

Bacteriological testing of groundwater is done at each well once per working day when the wells are operating. Testing is summarized in Table 6.1. Positive coliform counts are rare.

c) **Distribution System**

Bacteriological sampling is also done every day in the distribution system at seventeen rotating locations. Approximately 65 - 80 samples per month are analyzed. The Ontario Drinking Water Objectives suggest that 82 monthly samples should be taken based on a serviced population of 74,000.

SECTION B - FLOW MEASUREMENT

SECTION B FLOW MEASUREMENT

B.1 SURFACE WATER SUPPLY

a) Raw Water

The raw water flow is measured by a venturi tube located in the 750 mm dia. low lift pump discharge pipe. It has a differential of 1.736 m.w.c. (metres water column), a throat diameter of 430.08 mm and has a range of 12,000 to 90,000 m^3/d. The average flow for the plant was 18,000 m^3/d with flows as high as 27,000 m^3/d being measured during the study period.

b) Treated Water

The treated water flow is measured by a venturi tube located in the 900 mm dia. high lift pump discharge pipe. It has a differential of 2.083 m.w.c. at the rated flow of 75,000 m^3/d, a throat diameter of 415.41 mm and has a range of 12,000 to 90,000 m^3/d. The average flow for the plant over the study period was 15,650 m^3/d. However, flows as high as 26,060 m^3/d have been measured.

c) Backwash

The backwash water flow is measured by a venturi tube located in the 500 mm dia. backwash pump discharge pipe. It has a differential of 1.4 m.w.c. at the rated flow of 60,000 m^3/d, a throat diameter of 387.80 mm and has a range of 15,000 to 60,000 m^3/d.

d) Filtered Water

The filtered water flow from each of the four filters is measured by a venturi tube located in the 350 mm dia. discharge line. Each has a differential of 2.008 m.w.c. at the rated flow of 18,000 m^3/d, a throat diameter of 203.40 mm and has a range of 3,000 to 22,000 m^3/d.

e) **Backwash Tank Supernatant**

The pumped supernatant from the backwash holding tank is metered with a 75 mm dia. magnetic flowmeter. It has a maximum rating of 40 l/s, and is a Fischer and Porter Model 10D1419A.

f) **Plant Process Water**

Water for internal plant use, including filter surface wash, chemical mixing and domestic purposes, is taken off the high lift pump discharge (ahead of the discharge meter) and is itself metered with a 100 mm dia. Turbometer, rated from 1.0 to 63 l/s. The meter is a Rockwell Model W-1000 DR, with local indicator and totalizer.

B.2 GROUNDWATER SUPPLY

The method of measuring flow at the well pumping stations is by venturi tube, with the exception of the Steelton Well pumping station which incorporates an orifice plate.

The following table provides particular details regarding the flow measurement elements at the various locations. The table incorporates the old and new ranges of the flow transmitters associated with the flow measurement elements. New transmitters were added as part of the central monitoring equipment contract in 1986, during the construction of the new water treatment plant.

Flow measurement data is summarized in Table 1.0 in Appendix A.

FLOW MEASUREMENT EQUIPMENT DATA

Groundwater Supply

STATION	FLOW ELEMENT	RANGE	SCALE
Steelton*	Orifice Plate pipe I.D.=11.96 in. orifice 8.129 in.	0-200 in (0) 0-5.269 m (N)	0-3000 igpm (0) 0-20,000 m^3/d (N)
Goulais*	Venturi 10.22 in. x 6.992 in.	0-65.19 in (0) 0-2.173 m (N)	0-2000 igpm (0) 0-15,000 m^3/d (N)
Lorna*	Venturi pipe ID = 12 in (nominal)	0-146.36 in (0) 0-3.856 m (N)	0-3000 igpm (0) 0-20,000 m^3/d (N)
Shannon*	Venturi 15.00in. x 7.258in.	0-69.5 in (0) 0-2.136 m (N)	0-3.0 migd (0) 0-15,000 m^3/d (N)

* data obtained from Sault Ste. Marie Public Utilities Commission
N = new rating
O = old rating

The range and scale above accurately reflect the field conditions, although it is noted that any readings below approximately 12% of full scale will not be accurate.

B.3 VALIDITY

a) Surface Water and Groundwater Supply

Operations staff from the Sault Ste. Marie Public Utilities Commission have confirmed that the flow measuring devices are checked on a yearly basis for accuracy and calibration. During the study period, no major recalibration was performed on the flow transmitters. The Public Utilities Commission have trained personnel on staff to calibrate all flow transmitters.

The data from the study period for the water treatment plant contains some inconsistencies, with some treated water flows exceeding raw water flows. This can be attributed to incorrect calibration, which was subsequently rectified by the Public Utilities Commission, and the fact that the average flow rates are close to the low end of the meter range. This introduces the possibility of lower flow measurement accuracies.

B.4 RECORDING

a) Surface Water and Groundwater Supplies

Daily and monthly reports are produced by the process control computer for the entire supply system. All data is computer logged. Daily and monthly hard copies are produced, to be used and added to the historical files. The process control computer only retains the current month on its magnetic disc and the printed hard copies are the only records.

A copy of a typical daily report is included in Appendix B. It gives chemical consumption, water quality, power consumption, backwash reports, reservoir reports, wastewater reports and flow reports for all distribution system components.

Table 1.1 lists per capita flows for the years 1984 to 1986. Per capita average day consumption ranged from 450 - 470 litres. The maximum day to average day

ratio varied from 1.35 to 1.44. The average day flows were slightly higher than the range suggested in the Ministry of the Environment Guidelines, while the maximum to average day ratio is slightly lower.

The service area is shown in Figure 9 along with the location of all major system components.

SECTION C - PROCESS COMPONENTS

SECTION C PROCESS COMPONENTS

C.1 GENERAL

This Section includes detailed information on the unit processes and systems within the groundwater pumping stations and the surface water treatment plant.

The groundwater system consists of a series of wells and pumps, with disinfection only. The wells, while operating independently of the water treatment plant, suply to the same distribution system, each via their own connection to the system.

The water treatment plant, which was placed in service in 1986, employs direct filtration, with chemically assisted coagulation, flocculation, filtration and disinfection. Basic block diagrams are attached as Figures Nos. 10 and 11.

This Section also includes a series of photographs illustrating the major components and chemical feed systems.

C.2 DESIGN DATA

a) <u>Capacity</u>

(i) <u>Water Treatment Plant</u>

The first stage of the new water treatment plant has a rated capacity of 40,000 m^3/d. Two future similar stages would bring the capacity up to 120,000 m^3/d. The plant is rated conservatively and from the original pilot plant studies on Lake Superior water, it is expected that the plant will be capable of operating at 60,000 m^3/d when the raw water quality is good.

The new water treatment plant has an approved rating through Ministry of the Environment Certificate No. 7-0589-82-006 for 40,000 m^3/d.

(ii) Well Capacities

With all the wells in service, the ground water supply can deliver 37,906 m^3/d. These capacities are made up as shown in the following table.

	Location	Existing Capacity m^3/d
East	Shannon	6818
End	Lorna #1	6545
	Lorna #2	6545
	Sub Total East End	**19,908**
West	Goulais #1	5890
End	Goulais #2	3927
	Steelton	8181
	Sub Total West End	**17,998**
	Total East & West End	37,906

b) **Factors Affecting Capacity**

The combination of the new water treatment plant and the existing groundwater wells in Sault Ste. Marie mean that there are no major factors affecting system capacity.

Further distribution system developments, including Storage in Pressure Zone 2, are currently being planned or implemented such that the system has no significant limitations.

C.3 PROCESS COMPONENT INVENTORY

C.3.1 SURFACE WATER TREATMENT PLANT

a) <u>Intake</u>

The Lake Superior raw water intake is located at Gros Cap, and consists of 900 m of 1200 mm polyethylene pipe. The intake design criteria are as follows:

- rated capacity 150,000 m^3/day.
- depth at crib 15 m.
- side entry crib, with 75 mm/sec. maximum velocity at peak flow and even water entry acceleration.
- maximum intake velocity 1.95 m/s.
- intake pipe obvert minimum 0.5 m below hydraulic gradient at maximum capacity, with friction factor "C" of 100, and lake level equal to average daily all time minimum.
- crib coated with materials with low thermal conductivity and low friction to minimize frazil ice formation potential.

b) <u>Screening and Intake Wet Well</u>

The circular raw water wet well at the Gros Cap Pumping Station is divided into two cells, and also serves as a surge chamber. The pump floor elevation is above maximum surge level, based on a "C" factor of 150 and maximum all time lake level. The travelling screens, one per well, are sized to pass 60,000 m^3/d with a velocity of 0.6 m/s. In the event that one screen is out of service, the velocity is 0.9 m/s.

c) <u>Low Lift Pumping</u>

As a preamble to low lift pumping, it is pertinent to explain how the water treatment plant is supplied. The plant receives raw water by gravity via 7800 m of 750 mm diameter raw water main from the Marshal Drive control tanks. These

are in turn fed via 3000 m of 750 mm pipeline from the Gros Cap raw water pumping station. This system was designed to provide satisfactory steady state and transient hydraulic conditions.

The initial ratings for the raw water pumps at Gros Cap are as follows:

Raw Water Pump Ratings

Pump Number	Capacity l/s	Head m	Type	Manufacturer
1	175	63.8	Vertical Turbine	Floway
2	175	63.8	Vertical Turbine	Floway
3.	350	63.8	Vertical Turbine	Floway
4	350	63.8	Vertical Turbine	Floway

Initial station installed capacity is 90,700 m^3/d (1050 l/s) with a firm station capacity (1 large pump out) of 60,500 m^3/d (700 l/s).

Raw water enters both treatment plant raw water wells through a powered isolating ball valve and two regulating valves in series. The first regulating valve reduces pressure and the second valve controls the level in the raw water wells.

The initial ratings for the low lift pumps at the treatment plant are as follows:

Low Lift Pump Ratings

Pump No.	Capacity l/s	Head m	Type	Manufacturer
1	175	7.2	Vertical Turbine	Peerless
2	350	7.8	Vertical Turbine	Peerless
3	350	7.8	Vertical Turbine	Peerless
4	350	7.8	Vertical Turbine	Peerless

The installed capacity is 105,800 m^3/d (1225 l/s), with a firm station capacity (1 large pump out) of 75,600 m^3/d (875 l/s).

d) **Flash Mixing**

The discharge side of each low lift pump is equipped with a 450 mm diameter in-line blender, nominally rated for a flow of 30,000 m^3/d and with an effective range of 12,000 - 35,000 m^3/d. The blenders are Lightnin Model 8-LBS-5, each equipped with a 3.75 KW motor operating at 1800 rpm.

Based on the above parameters, the velocity gradient through the blender, which is a function of temperature, is shown in the following Table.

Temperature	Velocity Gradient
^{o}C	sec^{-1}
0	3710
10	4220
20	4950

Based on the flow range of 12,000 - 35,000 m^3/d, the Gt values vary from 1499 to 3278, using a water temperature of 10°C and detention times varying from 0.3 to 0.9 seconds

e) **Flocculation**

The plant utilizes four flocculation tanks, each 5.4 m x 5.4 m x 4.6 m deep. These can be operated in parallel or as two pairs in series for tapered flocculation. Each tank is baffled and utilizes a Lightnin Model XLEVM-15 flocculator mixer equipped with flow straightening vanes and manually adjustable speed control. Each flocculation mixer is driven by a 1.1 KW motor and is designed for a G value range of 20 to 70 sec^{-1} at 2°C. The detention time and velocities through the flocculation influent channel can vary depending on plant flow and are tabulated as follows;

Plant Flow m^3/d	Detention Time (minutes) Per Tank	Total	Tapered Flocculation (Two tanks in series)	Entrance Velocity m/s
40,000	4.83	19.32	9.66	0.403
60,000	3.22	12.88	6.44	0.604

For emergency purposes, a bypass is available around the flocculators.

f) <u>Sedimentation</u>

The Sault Ste. Marie Water Treatment Plant employs direct filtration, and a separate sedimentation process is not used.

g) <u>Filters</u>

The plant contains four dual media filters, each 8.6 m x 4.3 m x 3.5 m deep and consisting of the following physical system:

Underdrain:	Ecodyne "Partilok" strainers at 200 mm centres on PVC and concrete support columns.
Sand:	250 mm depth with an effective size (e.s.) of 0.44 and a uniformity coefficient (u.c.) of 1.4 in accordance with AWWA Standard B100 Section 2.2.
Anthracite:	550 mm depth with an e.s. of 0.90 and a u.c. of 1.38 in accordance with AWWA Standard B100 Section 2.3.

Each filter is equipped with a Hach Model 1720A turbidimeter to measure filter effluent turbidity. Filter influent turbidity is not measured, however raw water turbidity (prior to entering the low lift pump wells) is continuously measured using the same analytical equipment. Raw water turbidity ranges from 0.3 to 1.1 NTU and filtered water turbidity ranges between 0.1 to 0.5 NTU (as can be seen in Table 2.1 Appended).

Generally, filter runs of 72 hours are achieved. The clean bed loss varies with filter throughput. At a filter rate of 12 m/hr. the clean bed loss is approximately 0.95 m and at double this rating the clean bed loss is estimated to be 2.7 m. One of the parameters that terminates a filter run is filter head loss and this is currently set at 3.0 m.

Since the plant is comparatively new, there are no current concerns over media loss, nor over size deterioration. This will need to be monitored on an ongoing basis to determine the need for future maintenance. The following elevations will provide the basis for depth monitoring:

Top of Filter Box	El	212.700 m
Top of Weir	El	212.150 m
Top of Water	El	211.850 m
Top of Trough	El	210.010 m
Top of Anthracite	El	208.680 m
Top of Sand	El .	208.130 m
Top of Underwash	El	207.880 m
Bottom of Filter Box	El	207.430 m

The backwashing of filters can be undertaken automatically through the plant computer. The backwash program allows for variable wash rates based on temperature, and also has adjustable duration for low and high rate washes. The backwash system is capable of delivering a backwash rate of 60 m/hr (ie. 616 l/s or 114 cm/min.) at peak flows, with normal backwash rates of 475 l/s or 45 m/hr (ie. 76 cm/min.).

The duration of the wash cycle is usually determined by visual observation of the quality of the washwater discharging from the filter. A typical wash cycle is as follows:

	Backwash Rate	Duration	Volume m^3
Low initial rate	10 m/hr	2 minutes	12.5
High rate	60 m/hr	8 minutes	300.0
Low final rate	10 m/hr	2 minutes	12.5
		Total	**325 m^3**
4 filters @ 325 m^3 each filter			1300 m^3

On a daily basis, this equals approximately 3.25 percent of plant rated capacity.

The backwash pumps are of the horizontal split case centrifugal type. They are located in the high lift pump room and have the following ratings:

Backwash Pump Number	Flow l/s	Head m	Manufacturer
1	475	11.0	Warren
2	475	11.0	Warren

Each filter is also equipped with a Roberts surface wash system (nominal wash rate of 2.0 m/hr at 700 kPa). This system incorporates its own booster pumping units (horizontal, split case centrifugal type) rated as follows:

Surface Wash Booster Pump Number	Flow l/s	Head m	Manufacturer
1	17.5	47.5	Peerless
2	17.5	47.5	Peerless

h) Clearwells

The total volume of filtered water storage consists of the following:

	Volume m^3	Dimensions
Clearwell 1	500	11.3 m x 8.6 m x 5.6 m
Clearwell 2	500	11.3 m x 8.6 m x 5.6 m
Reservoir 1	6400	81 m x 20 m x 5.7 m
Reservoir 2	6400	81 m x 20 m x 5.7 m
Total	**13800**	

The clearwells and reservoirs are constructed from concrete. Filtered water from each pair of filters discharges to weir controlled clearwells, each with a capacity of 500 m^3. This provides 30 minutes chlorine detention time at a plant flow of 40,000 m^3/d, reducing to 20 minutes at a flow of 60,000 m^3/d.

Water from the clearwells is piped to a two compartment below grade reservoir with a total usable capacity of 12,800 m^3. Each compartment may be taken off-line without affecting plant operation. In addition, there is a direct connection between the filtered water conduit to the reservoirs and the pump suction header, such that both compartments may be taken out of service.

i) **High Lift Pumping**

The high lift pumping station is located at the rear of the plant between the clearwells and reservoirs. There are presently three high lift pumps with space for a fourth. They are rated as follows:

High Lift Pump Number	Flow l/s	Head m	Manufacturer
1	275	52	Patterson - Dual Drive
2	-	-	Future
3	275	52	Patterson
4	275	52	Patterson

The total capacity is 825 l/s or 71,300 m^3/d with all three units operating. Firm capacity is therefore set at 550 l/s (47,500 m^3/d) with one pump out of service.

The station is also laid out for a future Zone 2 pumping system. Two 2.9 m diameter x 6.5 m long air cushioned surge vessels are located on the discharge lines within the pumping area in order to dissipate transient pressure conditions in the discharge transmission system.

j) **Backwash Treatment and Sludge Disposal**

Two backwash water surge and holding tanks (each approximately 15.3 m x 5.4 m x 5.0 m deep) are located beneath the flocculators to provide settling and equalization of backwash water.

Backwash water is allowed to settle for a minimum of two hours (adjustable) before the supernatant is pumped to the external retention pond before discharging to the Little Carp River. The supernatant can be dechlorinated with sulphur dioxide prior to discharge. The variable speed supernatant pumps are controlled from the backwash tank level on a reverse acting basis. The supernatant pump data is as follows:

Pump Number	Flow l/s	Head m	Manufacturer
1	30	7.5	Fairbanks-Morse
2	30	7.5	Fairbanks-Morse

Sludge settles in hoppers located inside the backwash holding tanks and is pumped to the City sewer system for ultimate treatment at the new West End Sewage Treatment Plant. The sludge discharges through a 100 mm diameter polyethylene forcemain approximately 2600 m long and is pumped with two speed positive progressive cavity displacement pumping units rated as follows:

Sludge Pump Number	Flow l/s	Head m	Manufacturer	Drive
1	6.0/9.1	20/42	Robbins-Myers	Two speed
2	6.0/9.1	20/42	Robbins-Myers	Two speed

The lower speed (6.0 l/s) provides for a velocity of 0.78 m/s which is the normal setting of the pumps. Occasionally, the higher speed is employed to provide for flushing velocities in the order of 1.1 m/s.

More detailed information on the handling and disposal of plant wastes is contained in a separate report titled "Sault Ste. Marie Water Supply, Water Plant Optimization Study, Plant Waste Study".

j) **Plant Overflow**

The plant is protected by overflows at the following locations:

Raw Water Well
Filter Influent Channel
Clearwells / Reservoirs
Wastewater Storage Tank.

All overflows discharge to a channel draining to the Little Carp River. The Filter Influent Channel, however, overflows initially to the wastewater storage tank.

C.3.2 WELL PUMPING STATIONS

The following pump data is available on the well supplies:

Station	Pump Number	Flow l/s	Head m	Manufacturer	Type
Goulais	1	63.2	97.5	Layne	Vertical Turbine
	2	41.7	97.5	Layne	Vertical Turbine
Steelton	1	113.6	38.1	Layne	Vertical Turbine
	2	113.6	36.6	Cameron	Horizontal double Suction
Lorna	1	79.5	99.4	Layne	Vertical Turbine
	2	79.5	99.4	Layne	Vertical Turbine
Shannon	1	79.5	86.9	Layne	Vertical Turbine

C.4 CHEMICAL SYSTEMS

C.4.1 SURFACE WATER SUPPLY

a) <u>General</u>

The following is a list of chemicals that are presently being used or have been allowed for at the water treatment plant:

Chemical	Composition	Application	Control
Chlorine	Gas	Prechlorination - raw water wells; Post-chlorination- chlorine contact chamber directly after the filter	Flow paced (from raw water venturi); compound loop (from clearwell chlorine residual and composite filter flow).
Aluminum Sulphate	48.5 percent solution	In-line blenders (mechanical)	Flow paced (from raw water venturi)
Cationic high molecular weight polyelectrolyte (Percol LT35) (Not in use)	40% reactive (liquid)	In-line blenders	Flow paced (from raw water venturi)
Sodium Chlorite (Not in use)	Dry powder (77%)	To chlorine dioxide generator	Flow paced (from raw water venturi)
Sulphur Dioxide (Used as required)	Liquid 99.9%	To backwash water decant line	Composite Control (additive signal on backwash tank chlorine residual and decant flow)

Ammonium Hydroxide	Liquid (29.4% NH_4OH)	To plant discharge	Flow paced (from plant discharge venturi)

b) **Disinfectant**

Liquid Chlorine is stored in a separate area in the water treatment plant. It is delivered in 900 kg cylinders and the plant is capable of stocking sixteen containers. Chlorine usage is measured on two scales, each capable of handling two cylinders. An automatic transfer system switches operation of the cylinders and scales.

Three chlorinators are located in a room adjacent to the chlorine storage area. These units are manufactured by Wallace and Tiernan Ltd. and have the following ratings.

Pre Chlorinator	45 kg/day
Post Chlorinator	45 kg/day
Standby Chlorinator	45 kg/day

Chlorine is dosed at the raw water inlets to the low lift pump wells (pre chlorination) and in the chlorine contact chamber which is connected to the clearwells (post chlorination).

Aqua Ammonia (Ammonium Hydroxide) is injected into the plant discharge just downstream of the plant main isolation valve. The aqua ammonia combines with the free chlorine residual to form a combined residual. The hypochlorite ion to ammonia ratio is set at about 3:1 by weight.

The aqua ammonia system has been modified to allow bulk deliveries to 2 new storage tanks of 13,000 l capacity each, rather then the former deliveries in 170 kg steel drums. This solution is then transferred into two 500 litre fiberglass

tanks which are situated on weigh scales. The transfer is by gravity or by pumping depending on the relative level in the tanks. The previous delivery and transfer system caused considerable problem with ammonia fumes and was replaced.

Dosing equipment consists of two Wallace and Tiernan chemical pumps rated as follows:

	Minimum Duty	Maximum Duty
Duty Pump	20.47 l/day	103 l/day
Standby Pump	20.47 l/day	103 l/day

c) **Coagulant**

Liquid aluminum sulphate (alum) is supplied in bulk and stored at the water treatment plant in two 10,000 litre fiberglass tanks. It is dosed to the in-line blenders located directly downstream of each low lift pump. There is one duty aluminum sulphate pump and a standby pump which is shared with the polymer dosing system.

The aluminum sulphate is delivered through a chemical distribution header with automatic isolating valves, such that if a low lift pump is running, the isolating valve is open allowing the coagulant to be fed to the in-line blender associated with that pump. Transportation of the alum to the in-line blenders is carried out by addition to a waterline close to the dosing pumps. This reduces the system response time. (It was originally intended to use the water for flushing only, but the operation was changed to overcome long response times).

If no low lift pumps are in operation, flushing water is passed through the chemical lines continuously to each pump in order to keep the lines completely clear at all times.

The ratings of the Wallace and Tiernan coagulant dosage pumps are:

Duty Pump	57.8 l/day to 1386.8 l/day
Standby Pump	57.8 l/day to 1386.8 l/day.

d) **Polymer (Filter Aid)**

Liquid polymer is not presently used at the plant, but provision has been made for its use. The system is based on using 350 kg pallet tanks. Liquid polymer solution can be made up by a manually initiated automatic system. Metered dilution water is fed in conjunction with liquid polymer into two 5000 litre fiberglass holding tanks. A duty polymer metering pump rated between 250 l/day and 5400 l/day doses a dilute polymer solution to the in-line blenders.

e) **Sulphur Dioxide**

Liquid sulphur dioxide is supplied to the plant as a compressed gas in 68 kg cylinders and is drawn off as a gas. Sulphur dioxide can be injected into the backwash decant main which discharges to a man made pond at the front of the plant or to the plant overflow. This chemical is used to dechlorinate the backwash water prior to discharge to the Little Carp River if a residual is detected at the point of discharge. Operating experience has indicated that this does not usually occur.

The sulphonators are manufactured by Wallace and Tiernan Ltd. and are rated as follows:

Duty Sulphonator	4.5 kg/day
Standby Sulphonator	4.5 kg/day

f) <u>Chlorine Dioxide</u>

Provision for chlorine dioxide addition has been provided as a precaution only, to combat potential taste problems should they occur. Chlorine dioxide is generated by combining sodium chlorite in solution with an excess of chlorine and passing it through a reaction column. Sodium chlorite is delivered as a dry compound in 45 kg drums as 80% technical grade. The compound is mixed with water to a set concentration (approx. 20%) in a 2200 litre F.R.P. tank. The solution is drawn off by one of two Wallace and Tiernan pumps, leaving the second as a standby.

Duty Pump	650 l/day
Standby Pump	650 l/day

C.4.2 GROUND WATER SUPPLY

Three of the four well pumping stations, namely Lorna, Goulais and Shannon pump water directly into the Zone 1 pressure system. At these pumping stations, the water is disinfected to a combined residual leaving the station in the range of 0.4 to 0.7 mg/L after 30 minutes contact time. Each of these stations utilizes a gaseous chlorination and ammoniation system.

Each station is equipped with one Wallace and Tiernan chlorinator and ammoniator rated as follows:

Station	Chlorinator Rating kg/d	Ammoniator Rating kg/d
Goulais	13.6	6.3
Steelton	13.6	6.3
Lorna	13.6	6.3
Shannon	13.6	6.3

The chemical dosing point is in the well pump discharge line at each station. Ammonia is dosed ahead of chlorine to form chloramines, and to prevent formation of taste and odour causing compounds.

Contact time is provided at the Steelton well in a concrete reservoir, from which water is re-pumped into Pressure Zone 1 using a horizontal double suction pump. At the other wells, 30 minutes of contact time is provided in a section of 900 mm pipe at the rated flow. The contact time at the Steelton well is approximately 7 hours.

C.5 CONTROL AND INSTRUMENTATION

a) Surface Water Supply and Groundwater Supply

The filter plant is equipped with a central computer system utilizing two Digital Equipment Corp. PDP.11 microcomputers.

The system controls the following systems and major process blocks.

- Gros Cap Raw Water Pumping Station
- Water Treatment Plant Processes:
    - Pressure Reducing Station
    - Low Lift Pumps
    - Plant Flow
    - High Lift Pumps
    - Backwash Pumps
    - Filter Backwashing
- Well Pumping Stations/Zone 1 Level
- Zone 2 Booster Pumping Station/Zone 2 Level
- Daily and Monthly Report Generation

C.6 STANDBY POWER

In the event of a power failure from the main feeder, a transfer switch will automatically transfer critical loads to the second feeder. All other loads may be switched manually through the 600v secondary selective system, to the unaffected feeder.

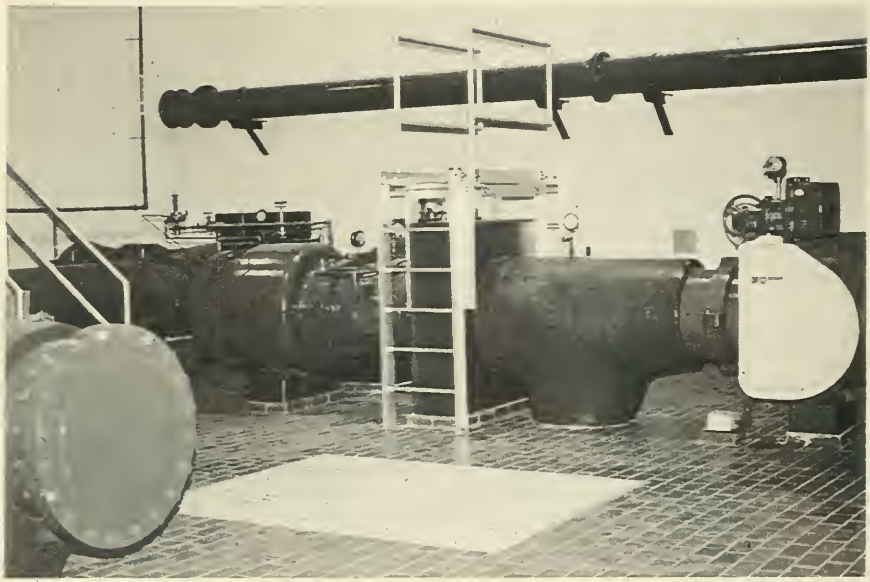
If the power outage is general, affecting both feeders, the 150 kw diesel generator will automatically start. The generator will restore power to critical loads only. (i.e. emergency lighting, controls, metering pumps), as well as to low lift pump No. 4. If the power outage is of extended duration, a 350 HP diesel engine may be started manually to drive high lift pump No. 1.

C.7 DRAWINGS AND PHOTOGRAPHS

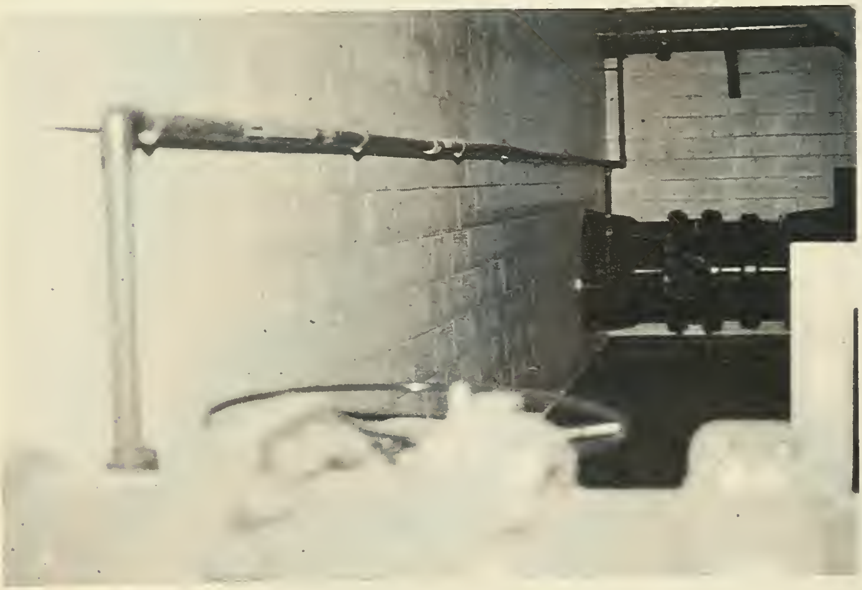
The following drawings are included in Appendix C;

Figure No. 1 Plant Schematic and Hydraulic Profile
Figure No. 2 Site Plan
Figure No. 3 Basement Plan, Elevation 201.5
Figure No. 4 Main Floor Plan, Elevation 207.5
Figure No. 5 Upper Floor Plan, Elevation 212.8
Figure No. 6 Building Sections
Figure No. 7 Building Elevations
Figure No. 8 Process Block Diagram
Figure No. 9 Distribution System

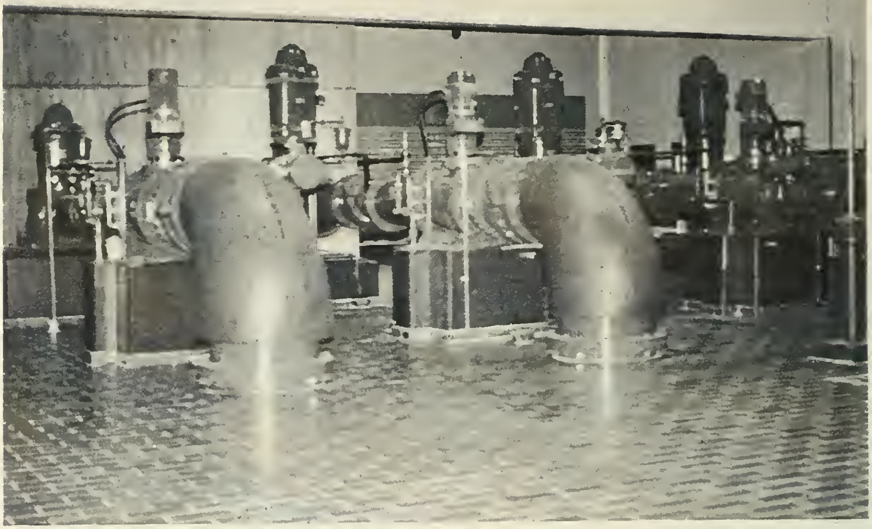
A series of photographs that illustrate the major components and chemical feed systems follow this section.



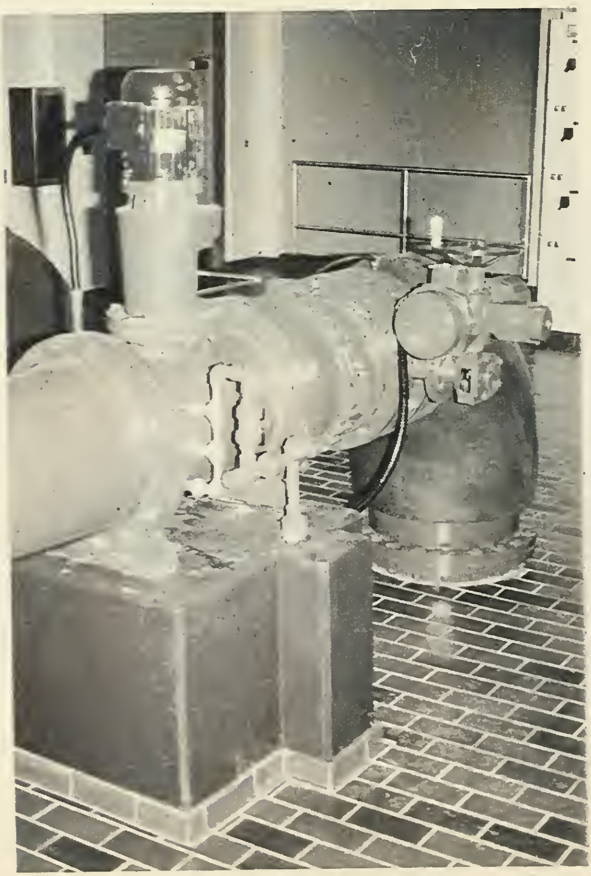
1. PRESSURE REDUCING STATION



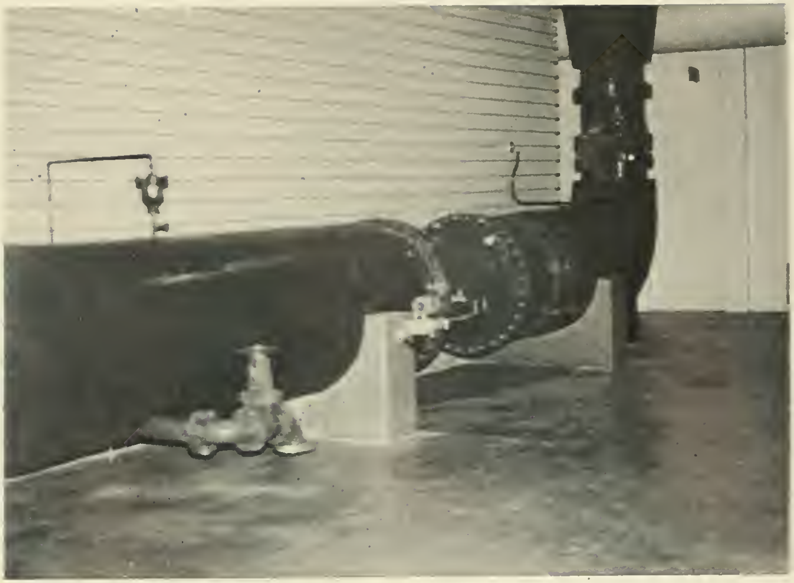
2. PRE-CHLORINATION DOSING POINTS.
RAW WATER INLET TO LOW LIFT PUMP WELLS



3. LOW LIFT PUMPS/IN-LINE BLENDERS

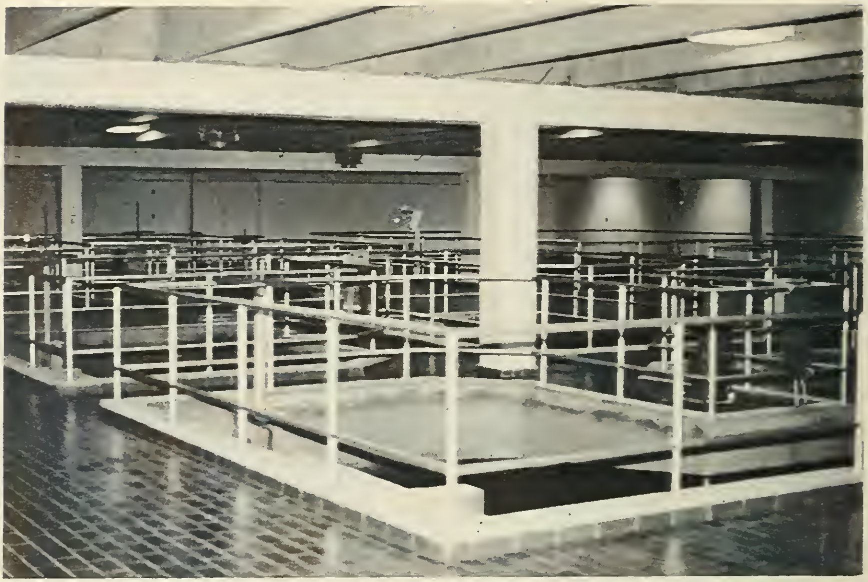


4. IN-LINE BLENDER

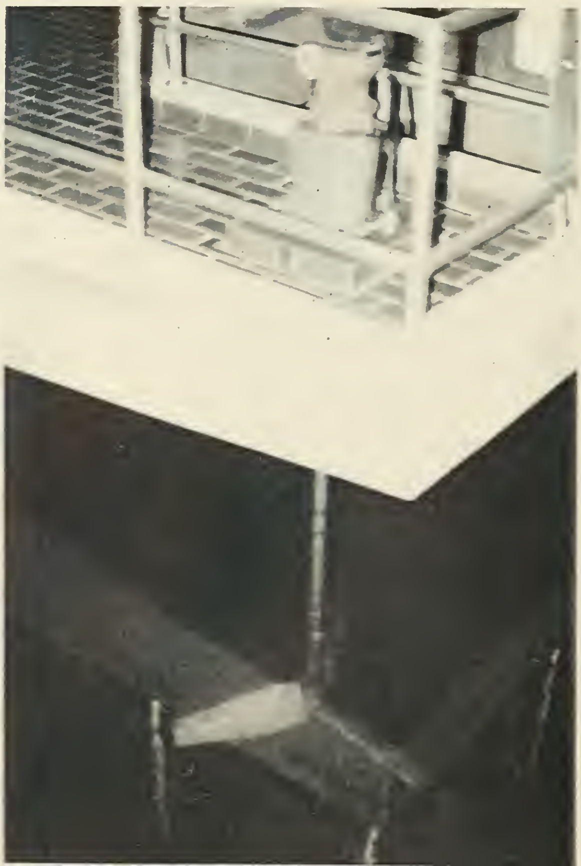


5. RAW WATER CONTROL VALVE AND VENTURI (TO FLOCCULATORS)

6. RAW WATER FEED CHANNEL UPSTREAM OF FLOCCULATION TANKS

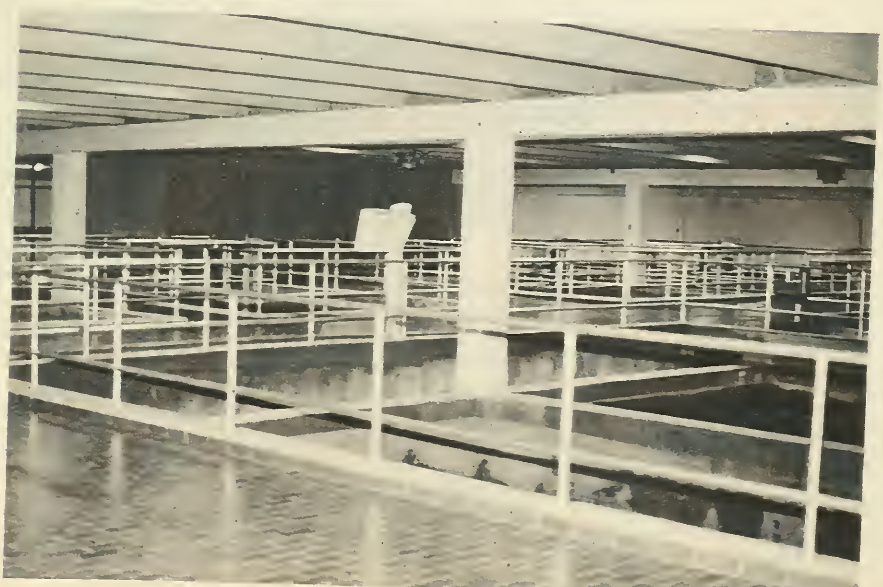


7. VIEW OF FLOCCULATION TANKS AND FILTERS (FLOC TANKS IN FOREGROUND)



8. FLOC MIXER

9. FLOC TANK OUTLET CHANNEL

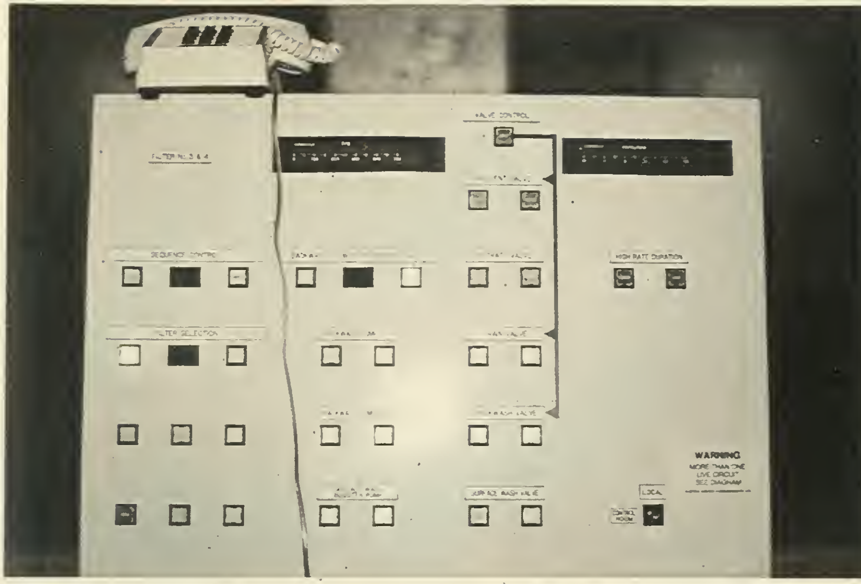


10. FILTER/FLOC TANK FLOOR (FILTERS IN FOREGROUND)

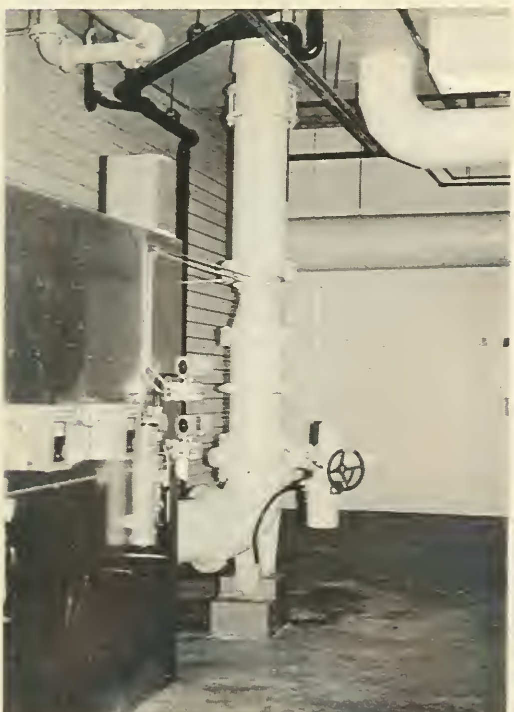
11. FILTER INFLUENT CHANNEL

12. FILTER 1 & 2 (IN OPERATION)

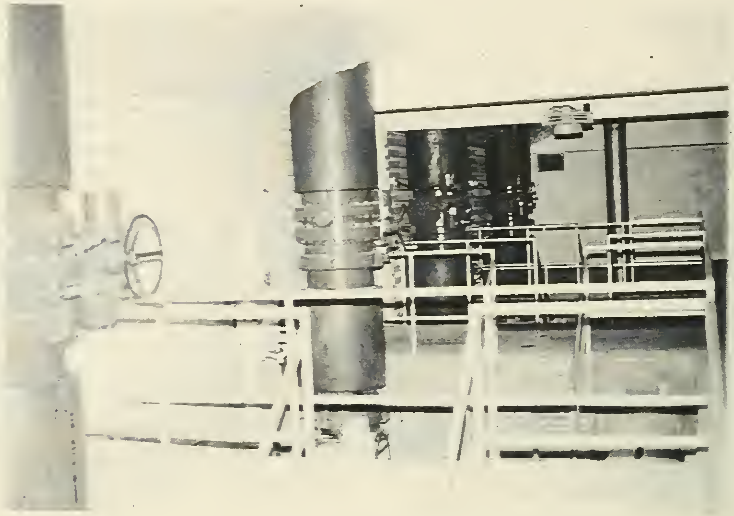
13. FILTER No. 4 (DEWATERED TO BACKWASH TROUGHS)



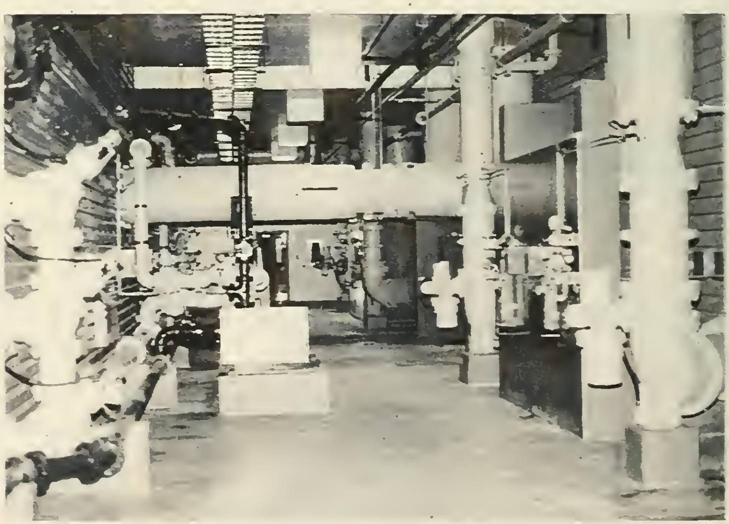
14. FILTER CONSOLE.(FILTER 3 & 4)



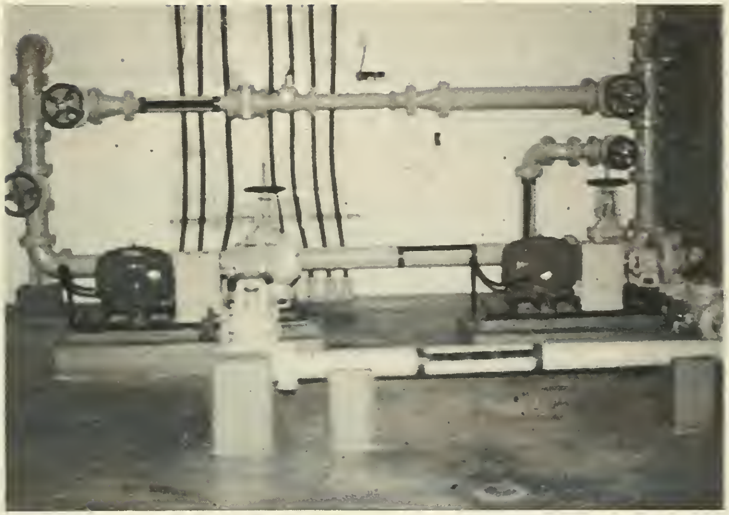
15. FILTER EFFLUENT PIPING, RATE OF FLOW CONTROL VALVE AND VENTURI



16. FILTER PIPING GALLERY (FILTER INFLUENT AND BACKWASH INLET PIPING)

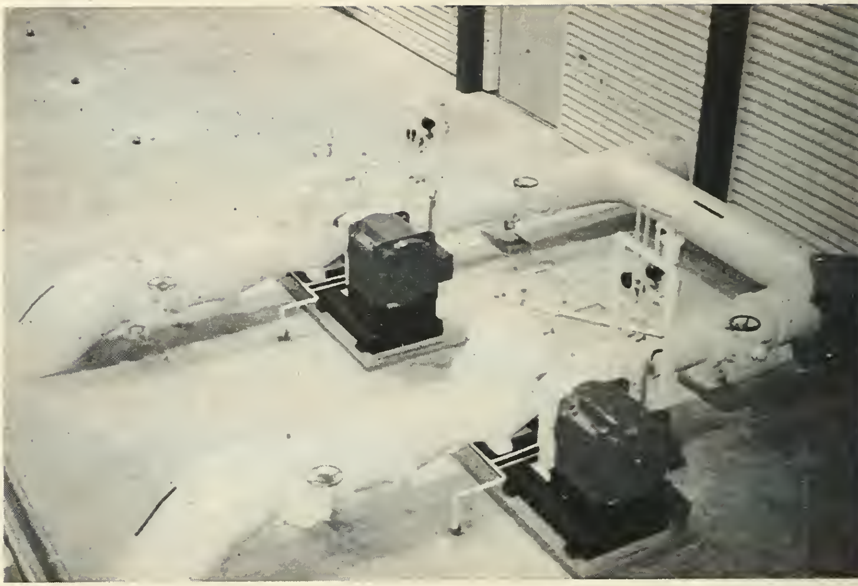


17. PIPING GALLERY (BACKWASH DRAIN,DECANT,SLUDGE AND FILTER EFFLUENT PIPING)

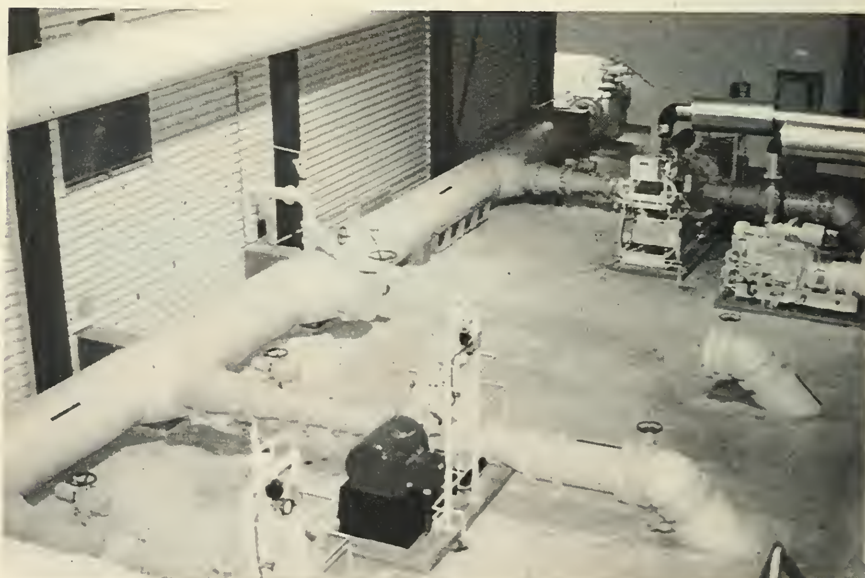


18. SURFACE WASH BOOSTER PUMPS

19. BACKWASH PUMPS (AT FLOOR LEVEL WITH AIR CHAMBERS IN BACKGROUND)

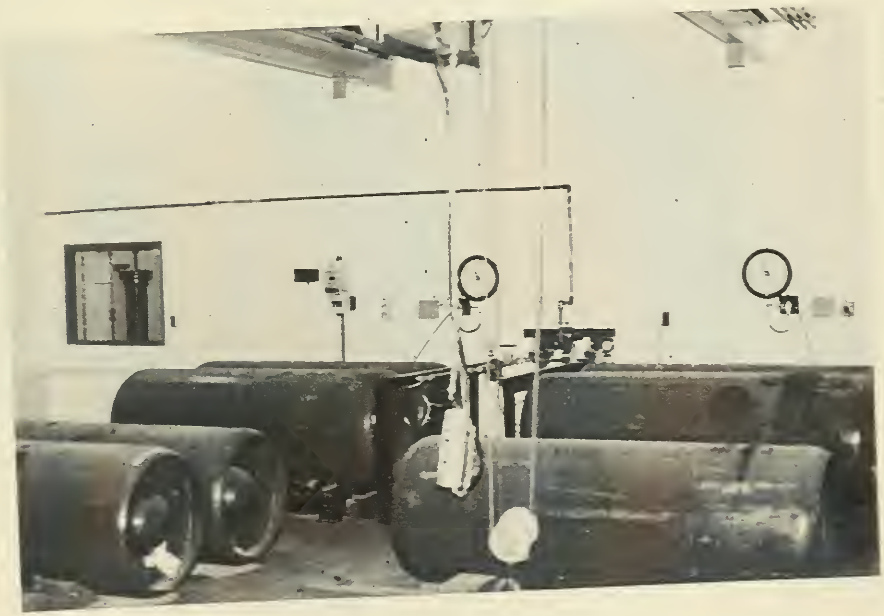


20. BACKWASH PUMPING UNITS

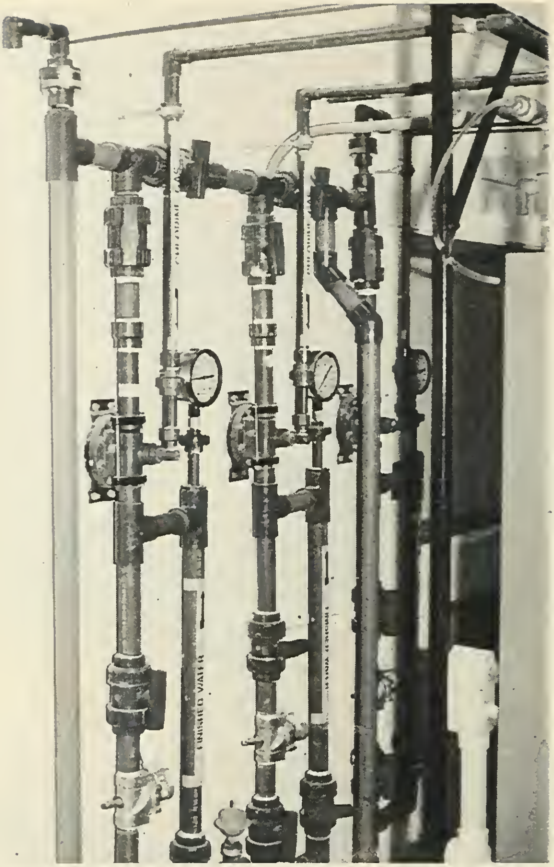


21. HIGH LIFT PUMPING UNITS(WITH STANDBY DIESEL GENERATOR IN BACKGROUND)

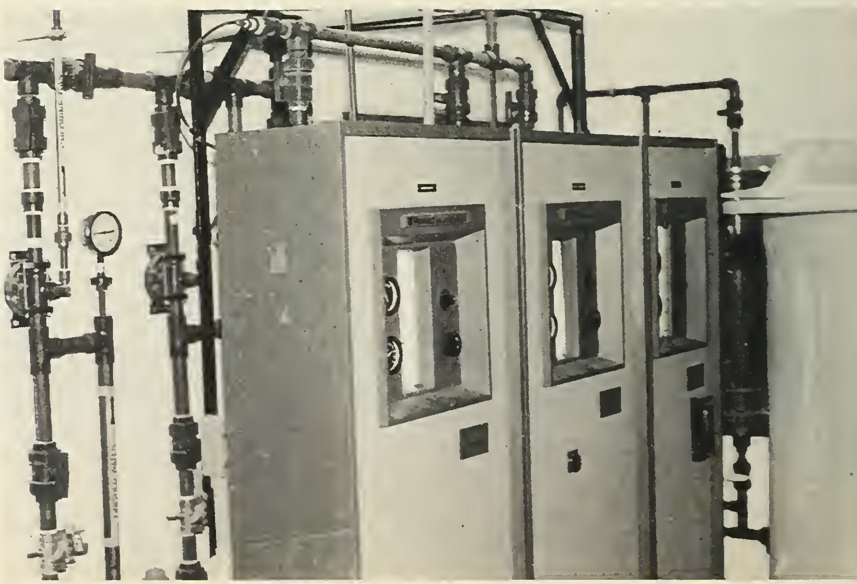
22. AQUA AMMONIA DOSAGE POINT (ON PLANT DISCHARGE)



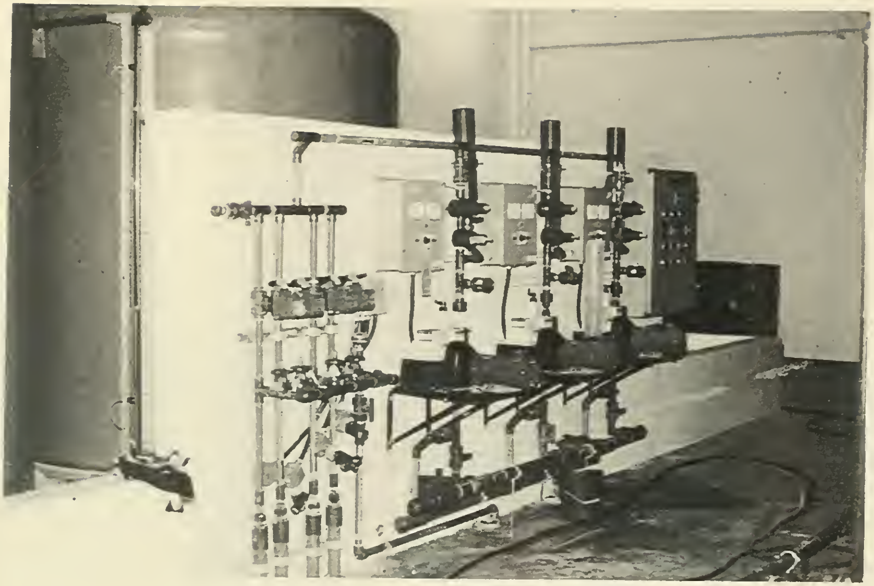
23. CHLORINE STORAGE ROOM



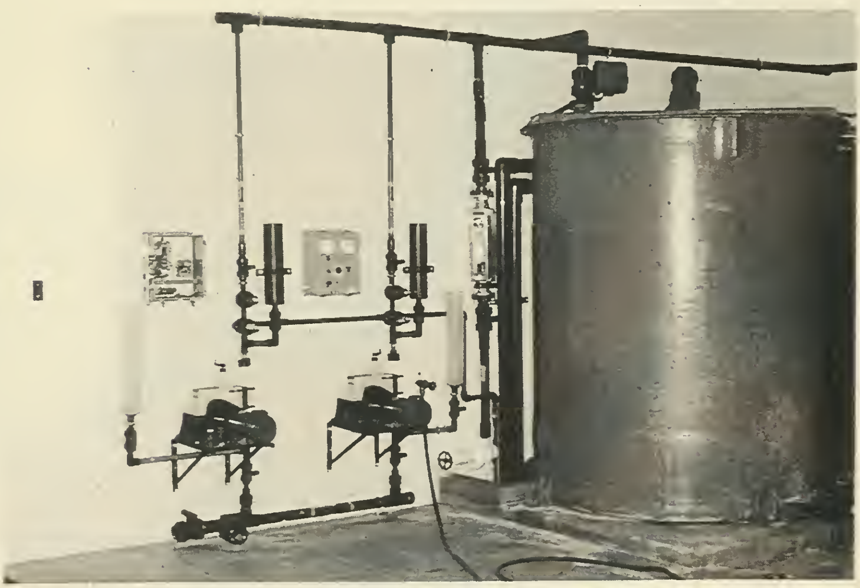
24. CHLORINATOR PIPING



25. PRE, POST AND STANDBY CHLORINATORS

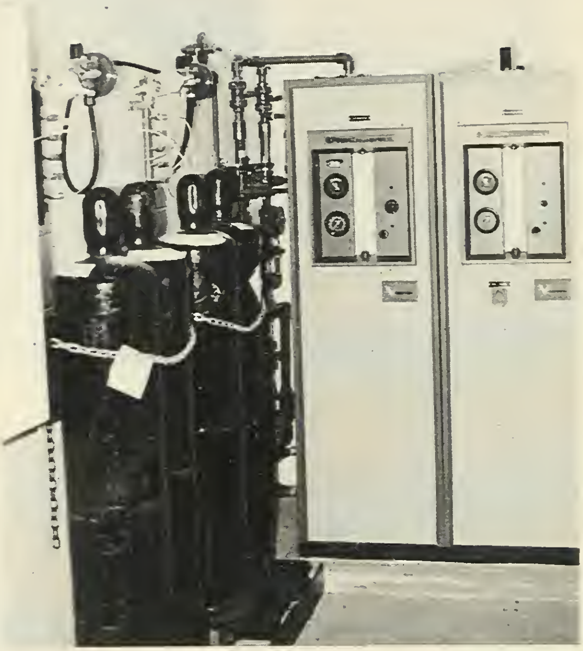


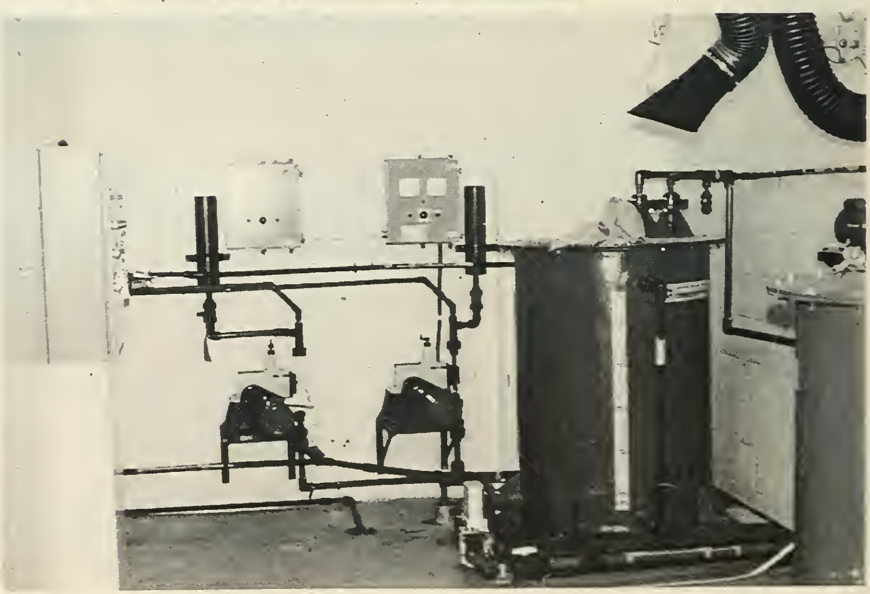
26. ALUMINUM SULPHATE STORAGE AND DOSING EQUIPMENT



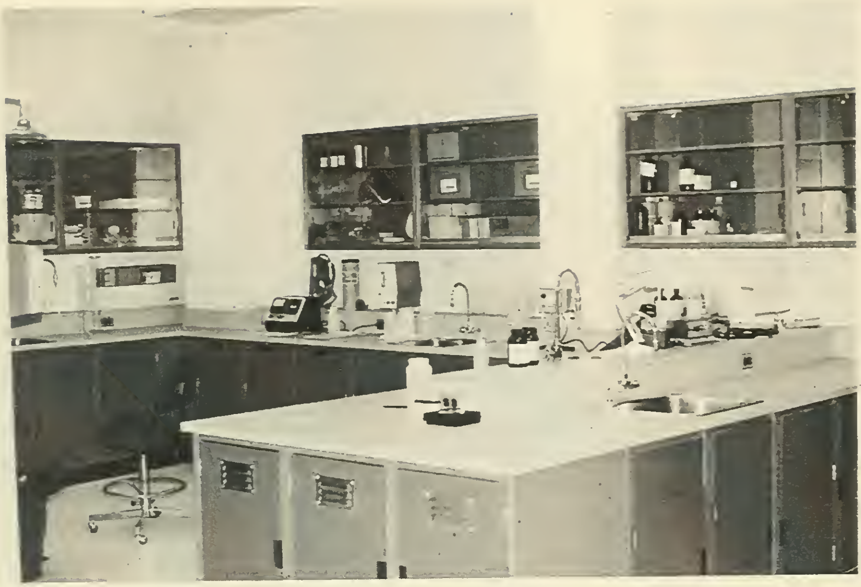
27. POLYMER MAKEUP SYSTEM

28. SULPHUR DIOXIDE SYSTEM





29. AQUA AMMONIA STORAGE AND METERING EQUIPMENT

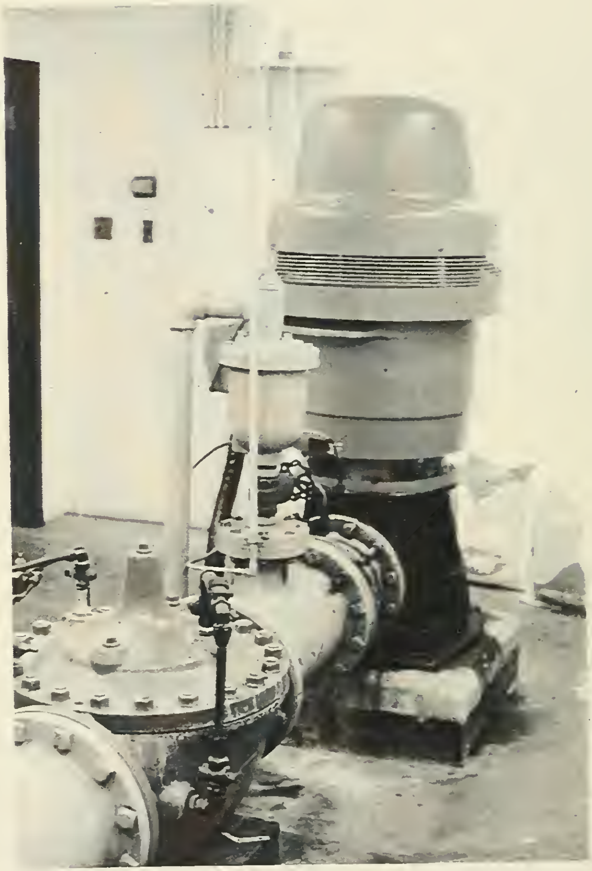


30. LABORATORY

WELL PUMPING STATIONS

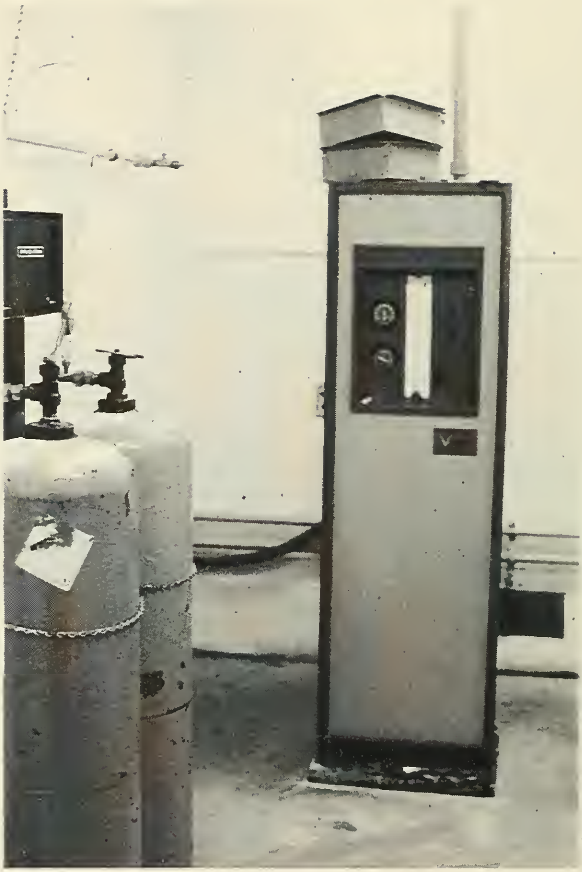
S 1 SHANNON WELL PUMPING STATION

S 2 SHANNON WELL PUMPING STATION

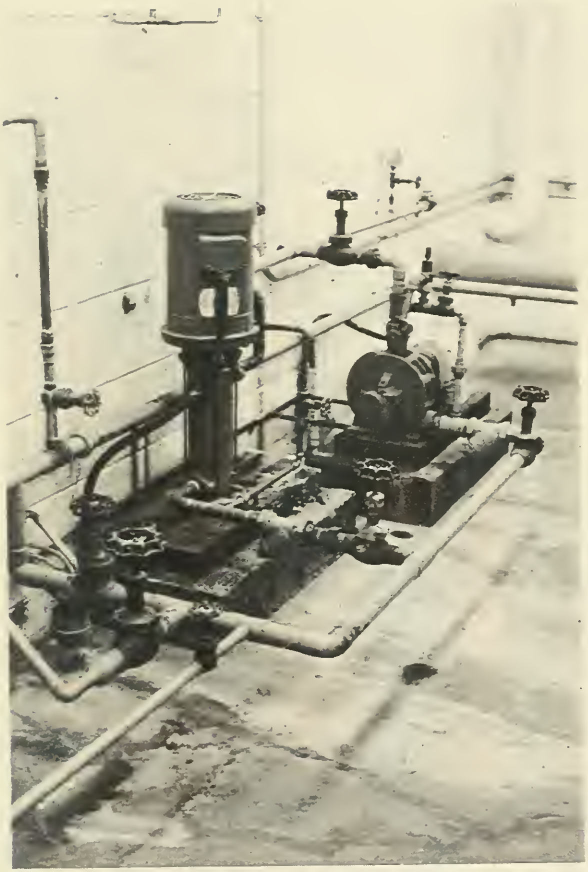


S 3 VERTICAL TURBINE PUMP AND CONSTANT FLOW CONTROL VALVE

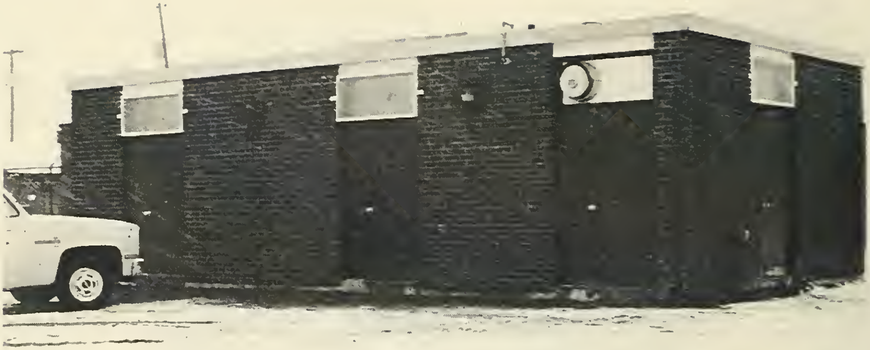
S 4 CHLORINATOR ROOM



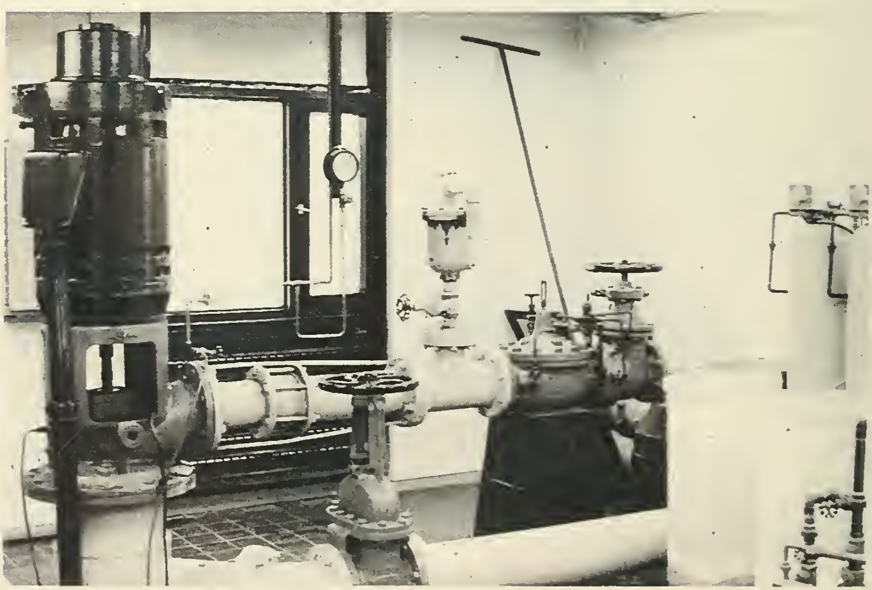
S 5 AMMONIA ROOM



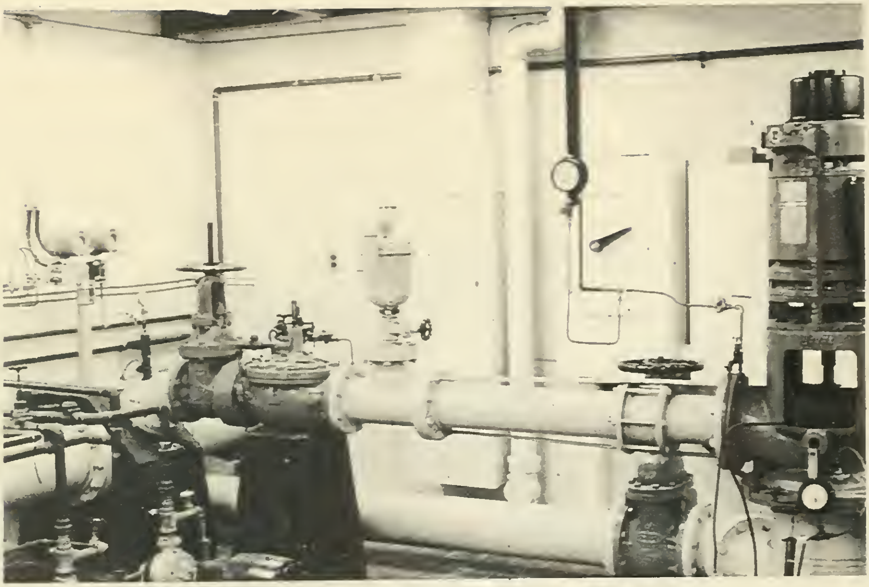
S 6 BOOSTER PUMPING SYSTEM FOR CHLORINE AND AMMONIA INJECTORS



G 1   GOULAIS WELL PUMPING STATION



G 2   PUMP No. 1

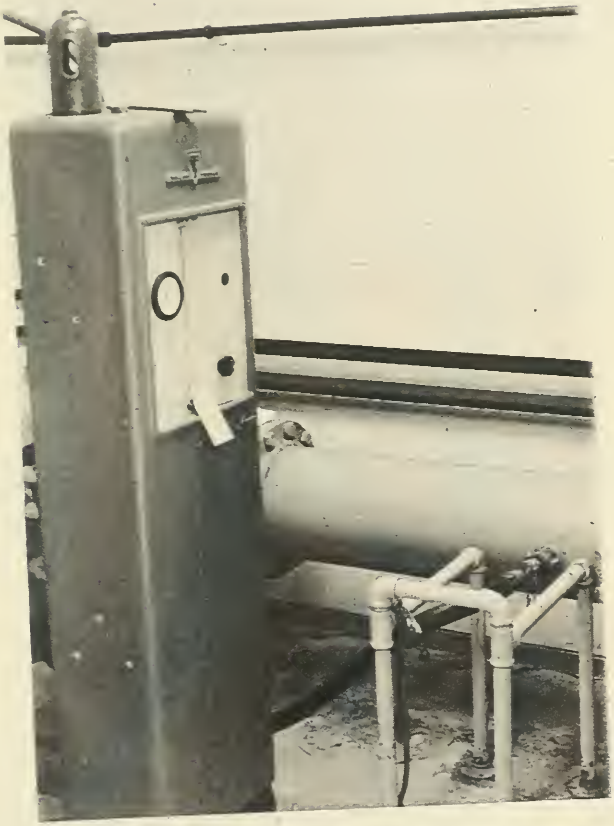


G 3   PUMP No. 2

G 4

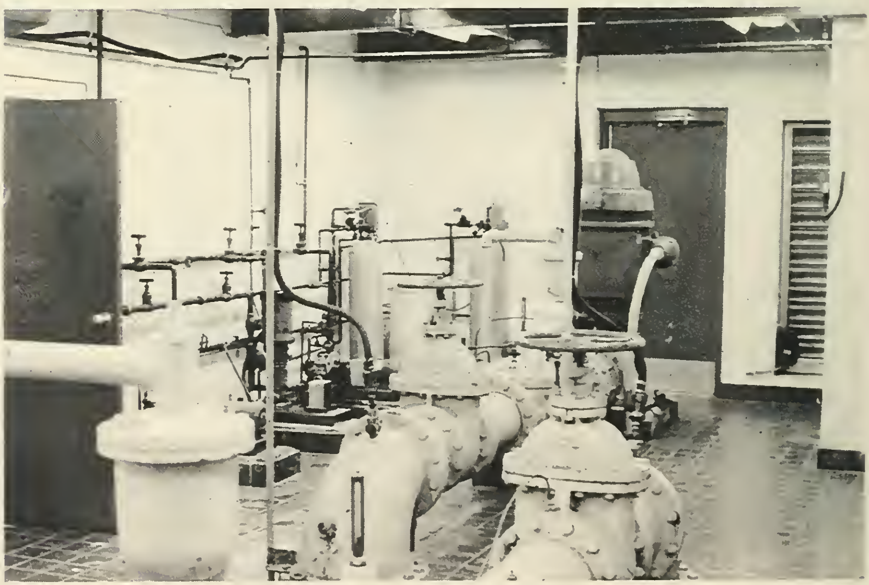
CHLORINE INJECTION POINT

G 5 CHLORINATOR

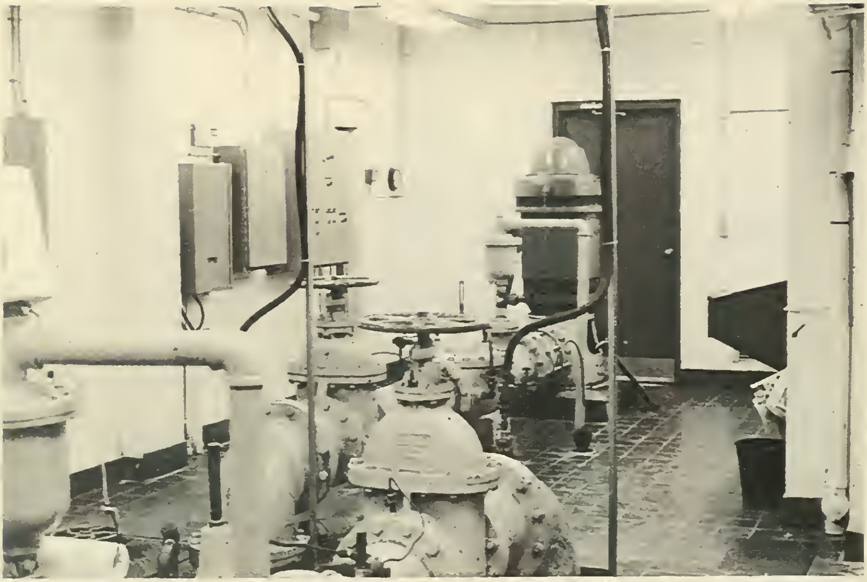


G 6   AMMONIATOR AND AMMONIA DOSING POINT

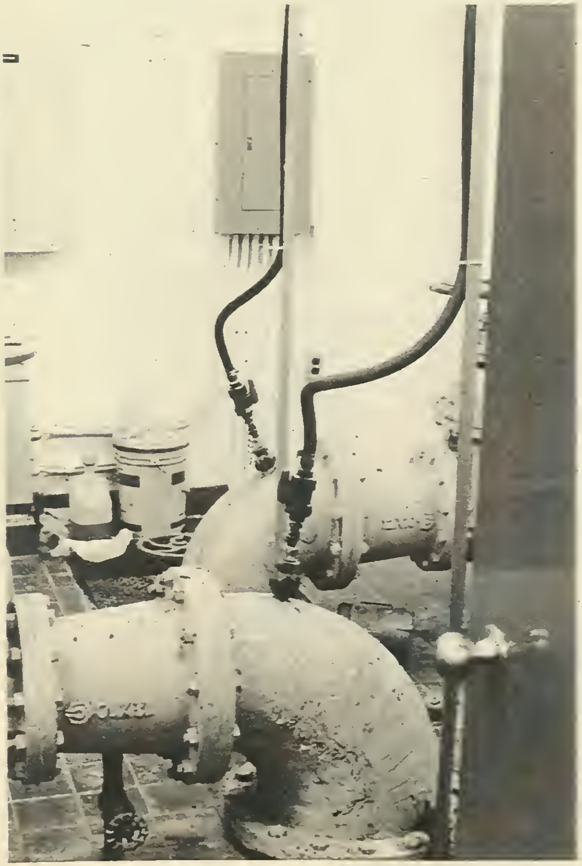
L 1 LORNA DRIVE WELL PUMPING STATION



L 2 PUMP No.1 (WITH SOFTENING SYSTEM IN BACKGROUND)



L 3 PUMP No.2



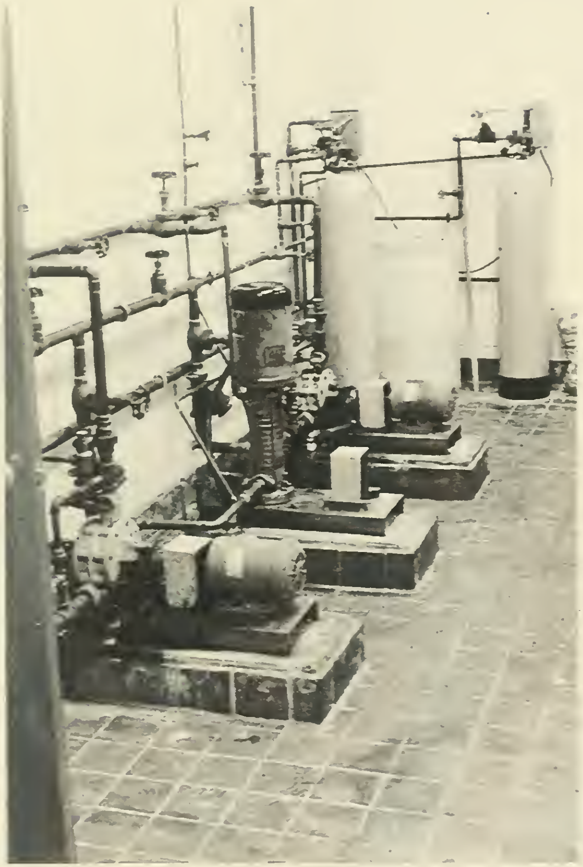
L 4

CHLORINE INJECTION POINTS

L 5 CHLORINATOR ROOM

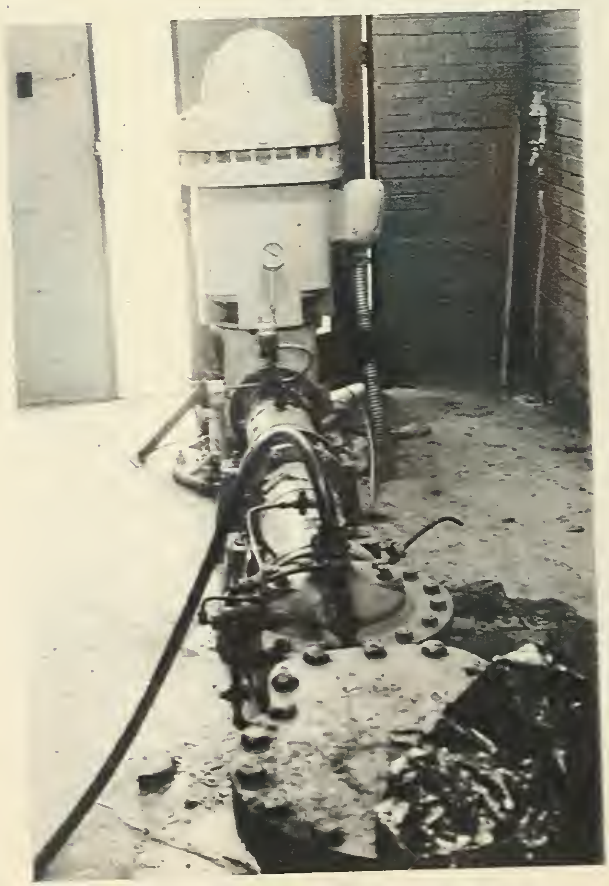
L 6

AMMONIA ROOM



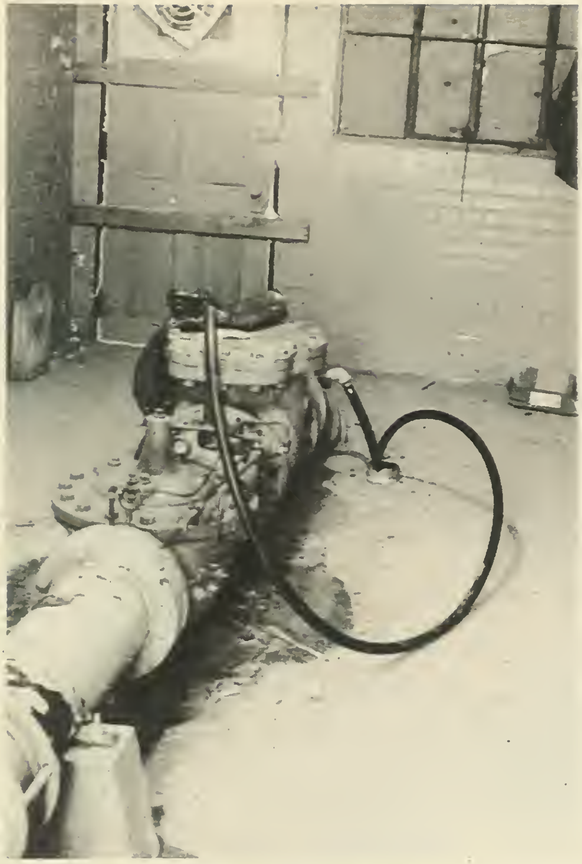
L 7 BOOSTER PUMPING SYSTEM FOR CHLORINE AND AMMONIA INJECTORS (SOFTENING SYSTEM IN BACKGROUND)

ST-1 STEELTON WELL PUMPING STATION



ST-2

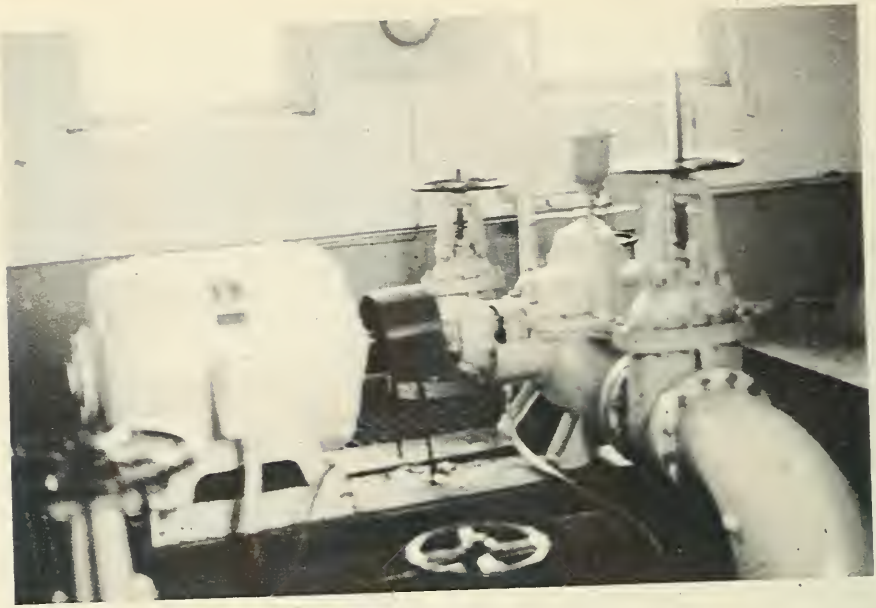
STEELTON WELL PUMP
CONTROL VALVE AND
CHLORINE DOSAGE POINT



ST-3

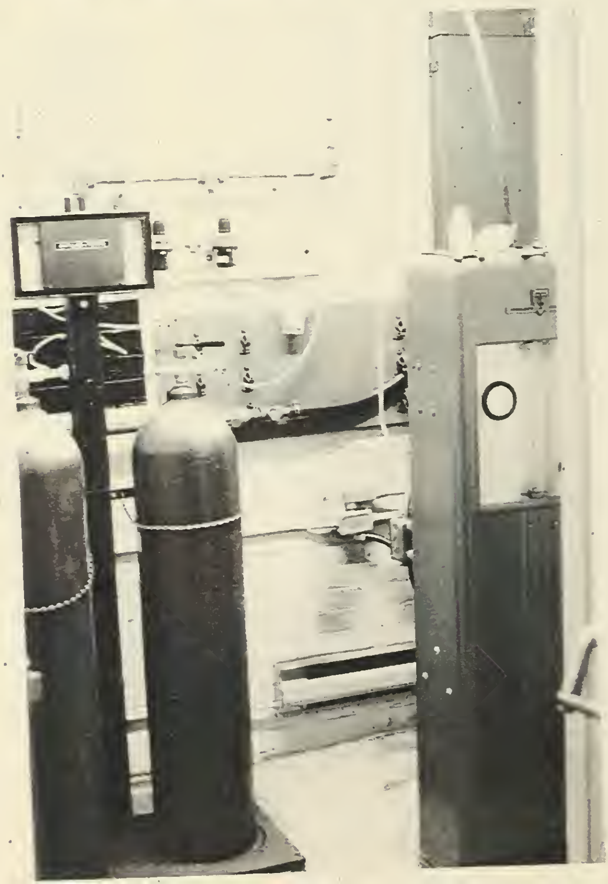
STEELTON WELL
PUMPING STATION
CONTROL VALVE

ST-4 STEELTON BOOSTER STATION



ST-5 STEELTON BOOSTER PUMP

ST-6 CHLORINATOR ROOM



ST-7 AMMONIATOR ROOM

SECTION D - PLANT OPERATION

SECTION D PLANT OPERATION

D.1 DESCRIPTION

a) General

The water treatment plant was placed in service in March of 1986. The plant operates continuously under the constant rate direct filtration mode assisted by a central control system located within the same facility. The current plant rating of 40,000 m^3/d is designed to meet demands for a population of up to 100,000 (in conjunction with the groundwater supply). Staged expansion in the future will provide for a population of 140,000 using the treatment plant alone.

b) Operation

The water treatment plant operates with a staff of 4 full time operators. The maintenance staff for the plant draws upon a pool from the Sault St. Marie Public Utilities Commission and staff are brought in as required. The groundwater wells are normally unmanned but are visited on a daily basis. The water treatment plant is manned 24 hours a day.

The Steelton Well operates continuously due to a need to maintain the present groundwater level in the area. That well, along with the Water Treatment Plant, provides a base level of supply to the system. Increases in supply are from the other wells and increasing plant throughput.

The following Sections describe the operation of each component of the Sault Ste. Marie Water Supply Systems, including both the groundwater and surface water facilities.

D.2 FLOW CONTROL

D.2.1 SURFACE WATER SUPPLY

a) <u>Raw Water (Low Lift Pumping)</u>

1. Low lift pumps may be controlled locally from the Motor Control Centre which takes precedence over any other mode, or remotely via the operator's console, enabling the operator to manually initiate Start and Stop control outputs for any pump in any sequence.

2. The pumps are prevented from being started at the operator's console if the raw watermain isolating valve is fully closed. The operator will receive an advisory message at the console.

3. Starting of any pump from the console will be inhibited, and require a further operator decision, if the net effect of this decision is to increase the current electrical load at the plant above a predetermined target value (in order to avoid unnecessary demand charges).

4. In the event of a power failure, the controller automatically outputs a stop command to all pumps.

5. Once the diesel generator starts and the discharge valve has been driven closed, low lift pump No. 4 can be operated.

b) <u>Filtration</u>

1. The flow rate control system is based on the concept of constant rate filtration and is achieved by means of a venturi flowmeter

and associated modulating control valves on the inlet to the flocculators, and on each of the discharge lines from the filters.

2. Coarse adjustment of plant flow rate is made by operator selection of low lift pumps. Fine adjustment of plant flow rate is achieved by manual adjustment of a master flow rate setter that establishes a common flow set point for each filter.

3. The level in the filter inlet channel provides the set point to the flow controller on the inlet to the flocculators to automatically maintain level stability.

4. Filter inlet channel level automatically overrides the master rate set point to the filter flow controllers to protect against dewatering the plant should the master rate set point exceed the capacity of the low lift pump(s) running at that particular time.

5. As the reservoirs near top water level, reservoir water level automatically overrides the master rate set point to minimize the frequency of plant shutdowns. Under this condition, plant flow is maintained above a predetermined minimum.

6. In the event of power failure, the master rate set point automatically goes to zero and is maintained at zero on restoration of power until readjusted by the operator.

7. All controller outputs may be adjusted manually.

8. In the event of central processor failure, all outputs fail to zero and manual plant control is established through manual loading stations. These are located in the control room and incorporate indication of the process variable.

c) **High Lift Pumping**

1. High lift pumps may be controlled locally from the MCC which takes precedence over any other mode, or remotely via the operator's console, enabling the operator to manually initiate start and stop control outputs for any pump in any sequence.

2. The pumps may be controlled automatically from the distribution system Zone 1 reservoir level in an operator selectable sequence and over adjustable level bands.

3. Starting of any pump from the console either manually or automatically will be inhibited, and require a further operator decision, if the net effect of this decision is to increase the current electrical load at the plant above a predetermined target value.

4. In the event of a power failure, the central controller automatically outputs a stop command to all high lift pumps. For continued supply, the diesel driven pump can be started.

d) **Filter Backwashing**

The basic sequence is as follows:

- Close the influent valve
- Drain the filter
- Close the filtrate valve
- Open the drain valve and the backwash valve
- Start the surface wash booster pump
- Open the surface wash valve
- Start the backwash pump
- Open the backwash flow control valve
- Ramp the flow rate to a low rate and hold

- If necessary start the second backwash pump
- Ramp the flow rate to a high rate and hold
- Close the surface wash valve
- Stop the surface wash booster pump
- If running, stop the second backwash pump
- Ramp the flow rate to a low rate and hold
- Ramp the flow rate to zero
- Close the backwash flow control valve
- Stop the backwash pump
- Close the drain valve and the backwash valve
- Open the influent valve to an intermediate position
- When the filter fills to a high level, open the influent valve fully
- Open the filtrate valve
- After several hours, start the supernatant decant pump

The above sequence is automated and controlled from the central computer system.

As with the operation of low and high lift pumps as previously outlined, the starting of a backwash sequence and backwash pump will be inhibited and require a further operator decision, if the net effect of the pump start is to increase the current electrical load above a predetermined value.

Other methods of manual control of filter backwashing are:

- two filter consoles located on the filter floor, each serving two filters.
- manual control at MCCs and valve equipment.

The filter consoles serve the following purposes:

- filter valve and equipment status indication
- local operator interaction with the automatic sequence
- manual control of the backwash sequence

In the event of a complete computer failure, filters may be backwashed from the filter console but with the following limitations:

- no backwash flow rate indication
- no indication of high rate wash duration
- no inhibit if the backwash drain valve is closed
- no override due to high plant power demand

The central computer can initiate backwashing based on head loss or effluent turbidity. The normal mode is, however, operator initiation based on observations of head loss, effluent turbidity and time since last backwash.

Automatic interlocks for filter backwashing are:

- no more than one filter to be backwashed at one time
- backwash water settling tank influent valve closed

e) <u>**Chemical Dosage Control**</u>

Pre-chlorination, sodium chlorite (via the chlorine dioxide generator), aluminum sulphate, polymer and aqua ammonia are flow paced from various flow transmitters throughout the plant using 4-20 mA signals. Sulphur dioxide is paced on the decant flow and the backwash water holding tank chlorine residual value (free) obtained from laboratory analyzed grab samples. Operator experience has been that detection of any chlorine residual is extremely rare.

Post-chlorination is controlled by a compound loop from clearwell chlorine residual (free) and composite filter flow. A free residual between 0.5 and 0.7 mg/l is maintained.

Pre-chlorination is flow paced from a 4-20ma signal from the raw water venturi flow transmitter.

Chlorine residuals are measured using a Wallace and Tiernan amperometric titrator. Free chlorine residuals are measured from clearwells 1 and 2 and a composite sample from backwash holding tanks 1 and 2. The post-chlorination combined residual is measured in the flow from the plant discharge at the high lift pump discharge header.

Alum

Initial plant operating data has indicated that 4 mg/l is an optimum alum dosage, and that little adjustment is required. Changes in raw water quality have been neither severe nor sudden and do not require close adjustment.

The alum metering pump stroke length is manually set and the pump speed is flow paced from the raw water venturi meter. Alum usage is measured by measuring the drop in level as noted in the sight glass on the two 10,000 litre storage vessels.

Polymer

As previously noted, polymer is not used at present, however the facilities exist for its dosage. The system is based on the use of Percol LT 35, a liquid cationic polymer. The installed system has a capacity of 5400 l/d of one percent solution or 54.00 l/d of liquid polymer on a 100 percent active basis. However, Percol LT 35 is only 40% reactive; and hence, on an active basis the metering pumps can deliver 21.6 l/d. Therefore, at a plant rating of 40,000 m^3, the maximum dosage would be in the order of 0.54 mg/l.

D.2.2 GROUNDWATER SUPPLY

a) Wells

1. Each well pump may be controlled locally from the MCC, which takes precedence over any other mode, or remotely from the operator's console at the water treatment plant, enabling the operator to manually initiate start and stop commands.

2. Each well pump may be controlled automatically by including it in the Zone 1 high lift pump automatic reservoir level control sequence (in the control computer).

3. Pump status is transmitted from the well pumping station to the water treatment plant operator's console.

4. Each well pump may be controlled automatically from measurements of system pressure transmitted to the central processor. Pump control sequences can be established for one or more well pumps based on pressure. These would operate separately from other automatic or manual control modes for remaining pumps in the system.

b) Chemical Dosage Control

The ammoniators and chlorinators at each well pumping station are manually set. Each pump discharge is equipped with a constant flow control valve and hence no modulation in dosage of chlorine and ammonia is necessary.

Combined residual is manually checked daily at each well pumping station using a DPD method and logged into a station manual. Table 3.0 appended has been completed for each well pumping station for the month of July only, since the combined residual data is virtually the same for every month.

D.3 OPERATION PROCESS AND CONCERNS

D.3.1 SURFACE WATER SUPPLY

Due to the recent start-up of the water treatment plant and the complexity of the central control system, it would be premature to quantify and elaborate on any operational problems until additional operating experience has been obtained.

Items such as system software and the aqua ammonia transfer system at the water treatment plant are currently being or have been enhanced.

Based on early operational experience wherein turbidity increased slightly in the raw water transmission system, some settling was occurring in the raw water mains from Gros Cap. A routine flushing was therefore instituted. The raw water regulating valves (see Section 3.2.1.b) are opened to permit a flushing velocity, until the discharge is observed to be clear. The flow is directed through the treatment process. The plant has proven capable of handling this load without adjustment, with an only observed increase in treated water turbidity from 0.2 to 0.4 NTU.

The raw water main has been flushed three times during the last three years. On the first occasion, sediment was discharged, however, on the last two occasions, no sediment was observed. It is thought that the first flush removed sediment due to construction materials and that sedimentation of the main is not an ongoing problem.

D.3.2 GROUNDWATER SUPPLY

Due to the relative hardness of the groundwater, it hadbeen necessary to soften the injector water supply to the ammoniators at each well pumping station. This was a costly process which is no longer necessary due to the use of aqua ammonia in lieu of anhydrous ammonia.

Phenols are known to exist in the west end wells, Steelton and Goulais. This cannot be supported by chemical analysis because their occurrences, above trace amounts, are isolated. The Public Utilities Commission's experience is that taste and odour problems arise within two to three days any time ammonia dosing is stopped.

The west end wells are artesian. The Steelton well is operated on an ongoing basis as a base load pump in order to prevent a rise in groundwater levels in the surrounding area. When the pump is occasionally shut down for short periods, one of the Goulais wells is run to maintain the lowered water table. This would need to be considered should these wells no longer be required for drinking water supply purposes.

The Lorna well experiences occasional problems from iron bacteria. Headloss measurements through the well screens are taken weekly. When headloss becomes excessive, the wells are shock treated with chlorine. This practice occurs every few years. As noted in the Recommendations included with this study, the well screen should be examined for deterioration due to attack from such chlorine doses.

At the Steelton well, the well pump discharges into a concrete reservoir and then to the distribution system through a separate high lift pump. The roof of this reservoir requires examination and possible repair. As an alternative to repair, consideration should be given to replacement of the existing well pump with a unit capable of pumping directly into the system, and to provision of an oversized discharge main for chlorine contact purposes (as at the other wells).

D.4 SAMPLING AND MONITORING

D.4.1 SURFACE WATER SUPPLY

Several physical and chemical water quality characteristics are specifically sampled and monitored at the water treatment plant. Parameters that are continuously sampled and monitored are listed in the following Table:

Parameter	Equipment	Locations
Temperature	Bristol Signature RTP Model T319 bi-metallic Sensor	Raw water inlet to plant.
pH	Rosemount Model 381-1181	(i) Raw water inlet to plant; (ii) Plant discharge.
Chlorine Residual	Wallace and Tiernan A-773/A-780	(i) Clearwell 1 and 2 composite sample (free); (ii) Plant discharge (combined); (iii) Backwash holding tank 1 and 2 composite sample (free).
Turbidity	Hach Model 1720A	(i) Raw water inlet to plant; (ii) Filter 1,2,3, and 4 effluent; (iii) Plant discharge.

The signals from the analytical equipment listed above are transmitted to the plant computer which logs the daily high and low values as well as providing average values.

Grab samples can be obtained from many points within the plant. The plant laboratory is equipped with the instruments listed below:

- Corning Digital pH meter
- Hach 2100A Turbidimeter
- Wallace and Tiernan A-790 Chlorine Residual Titrator

These are used to calibrate the continuous monitoring instruments outlined above. The continuous monitoring instruments are cleaned and calibrated weekly.

Bacteriological samples are taken once per eight hour shift at 3 locations. The results are summarized in Table 6.2.

- Raw water wells
- Clearwell outlets
- Treated water at high lift discharge

Every two weeks, samples are taken of the raw water at Gros Cap and the plant treated water (at the High Lift discharge) and analysed by the Ministry of the Environment laboratory for the following parameters:

Iron
Aluminum
Cyanide (Raw only)
Conductivity
Hardness
Alkalinity
pH
Chloride

Turbidity
Colour
Phenol

The cyanide is monitored for historical reasons which are no longer valid but are carried on as a matter of course. The original Huron Street Pumping Station drew water from downstream of a potential cyanide source. The Gros Cap supply is now upstream of that source and therefore cyanide testing on a regular basis is not strictly required.

D.4.2 GROUNDWATER SUPPLY

One east end and one west end well is also sampled and analyzed for the same parameters as surface water every two weeks, such that all four wells are covered on a monthly basis.

Combined chlorine residual is manually measured using the DPD method and recorded, as well as chlorine and ammonia consumption is a station log book at each well pumping station.

D.4.3 DRINKING WATER SURVEILLANCE PROGRAM (DWSP)

The Sault Ste. Marie PUC has been participating in the DWSP program since April 1987 (although it should be noted that Stainless Steel sampling lines are not used - most lines as installed in the new plant are copper).

Samples are taken at the plant, the Steelton and Lorna Wells and at 2 homes in the distribution system on a monthly basis. The Goulais and Shannon Wells are sampled twice a year.

No results were available during the study period.

SECTION E - PLANT PERFORMANCE (Particulate Removal)

SECTION E PLANT PERFORMANCE (PARTICULATE REMOVAL)

E.1 TURBIDITY REMOVAL

E.1.1 SURFACE WATER SUPPLY

a) **General**

Of all the characteristics which give an indication of poor water quality, turbidity is considered as one of the most important. It has been shown in many studies that the particulates responsible for turbidity can harbour hazardous materials as well as bacteria, shielding them from disinfection. It is for this reason that the guidelines for water treatment in Ontario require treated water to have a turbidity of less than 1 NTU and preferably lower. Seasonal variations in the turbidity of a raw water supply impose requirements on a water treatment plant design to achieve low turbidity all year round.

b) **Plant Performance**

The raw water from Gros Cap that is treated at the Sault Ste. Marie Water Treatment plant currently undergoes pre-chlorination, coagulation with aluminum sulphate, flocculation, filtration, post-chlorination with residual control and finally addition of aqua ammonia (chloramination) before discharge to the system. The turbidimeters used at the plant are all Hach Model 1720A. These monitor the water at the raw water inlet to the plant, at the discharge of each of the filters and at the plant discharge. The plant turbidimeters are calibrated weekly against a laboratory turbidimeter, Hach 2100A, at a value of 0.72 NTU using a Hach formazin standard. This procedure ensures that the results are consistent and accurate.

Figure 4a shows the fluctuations in raw water turbidity at the plant. As can be seen from this figure, the turbidity of the raw water is very good with average values below the Ontario Maximum Acceptable Concentration (MAC) of 1.0 NTU. However, turbidity increases are experienced occasionally. This treatment

plant was commissioned in March, 1986. Therefore, all conclusions reached are based upon just over one year's results during the study period.

The range of treated water turbidity is from 0.1 to 0.3 NTU, which is below the MAC of 1.0 NTU. The results show a considerable reduction in turbidity in the already low turbidity raw water. As can be seen from Table 4a, the turbidity can be reduced to 0.1 NTU from 1.1 NTU. This represents a filter operating efficiency of 91%.

Overall, however, we believe that this plant reduces turbidity to as low as is currently achievable. The filter runs are always terminated on headloss readings or length of filter run, as opposed to turbidity breakthrough.

c) <u>Treatability Testing</u>

(i) <u>Pilot Plant Study</u>

As a result of the low turbidity levels consistently achieved by the Sault Ste. Marie Water Treatment plant and the fact that the plant uses direct filtration, it was decided by Proctor & Redfern to conduct full scale plant trial runs instead of jar testing, since the latter could only provide data of limited value.

On examination of field pilot studies carried out at the intake at Gros Cap by Proctor & Redfern in 1983, the following observations and conclusions were made:

- Runs in excess of 24 hours can be achieved at filter rates of 12 and 18 m/hr.

- Aluminum Sulphate at dosage rates of 4 mg/l yielded excellent results as measured by the degree of turbidity removal.

- Dosing with both alum and polymer (Percol LT35) made no appreciable improvement in performance.

- At 12 m/hr., there was very little difference between runs using 4 mg/l alum or 0.25 mg/l Percol LT35, both achieving good turbidity removal.

- At the 18 m/hr. rate there was a substantial deterioration in the 4 mg/l alum runs whereas the 0.25 mg/l Percol LT35 still provided excellent turbidity removal.

During the plant trials carried out in October, 1987 the following alternatives were investigated:

- Alum dosages of 2, 4, 6 mg/L
- Pre-chlorination at 0.35 and 0.7 mg/L
- Flocculators run in series or in parallel.

From these trials and the results summarized in Table 4b, Alum at 6 mg/L and prechlorination at 0.7 mg/L gives marginally better results, with the flocculators in series rather than in parallel.

Alum at 2 mg/L, pre-chlorination at 0.7 or 0.35 mg/L, flocculators in series or in parallel made no difference to the final turbidity of the treated water.

Alum at 4 mg/L, pre-chlorination at 0.7 or 0.35 mg/L flocculators in series or in parallel similarly made little difference to the turbidity of the treated water.

By comparing the plant filter runs with the pilot filter runs, shown in Figures 4c to 4f, it can be seen that the pilot plant runs give very similar results to that of the plant currently in operation when 4 mg/L of alum is used as the coagulant.

Aluminum residual levels in the treated water range from 110 to 125 ug/L. While this marginally exceeds the guideline for aluminum, it is a typical concentration for treated water. Acidification of the raw water in order to reduce either alum dosage or soluble aluminum levels is not desirable. Due to the pH and alkalinity of the water, some acid would have to be added to obtain an optimum coagulation pH of 6.3. The effect of this would be to reduce the Langelier Index

to a more negative value. This would provide a more corrosive water unless final pH adjustment was carried out at the plant. Further, due to the size, distribution and low concentration of particulates in the raw water, it may be extremely difficult to achieve improved turbidity removal, even at lower pH ranges. Aluminum residuals are discussed in more detail in the following Part d. iii) of this Section.

In previous pilot runs, undertaken in 1983 at lower temperatures, headloss increased at a slower rate at lower temperatures. Under these conditions with the cold water, poorer turbidity results were achieved.

Temperature	Alum mg/L	Turbidity of Effluent NTU
15°C	4.0	0.16
3°C	4.0	0.4
15°C	6.0	0.17
3°C	6.0	0.3

Percol LT35 gave very long filter runs in this case, but filtered water was of poorer turbidity (0.3 NTU).

d) <u>Optimum Removal Studies</u>

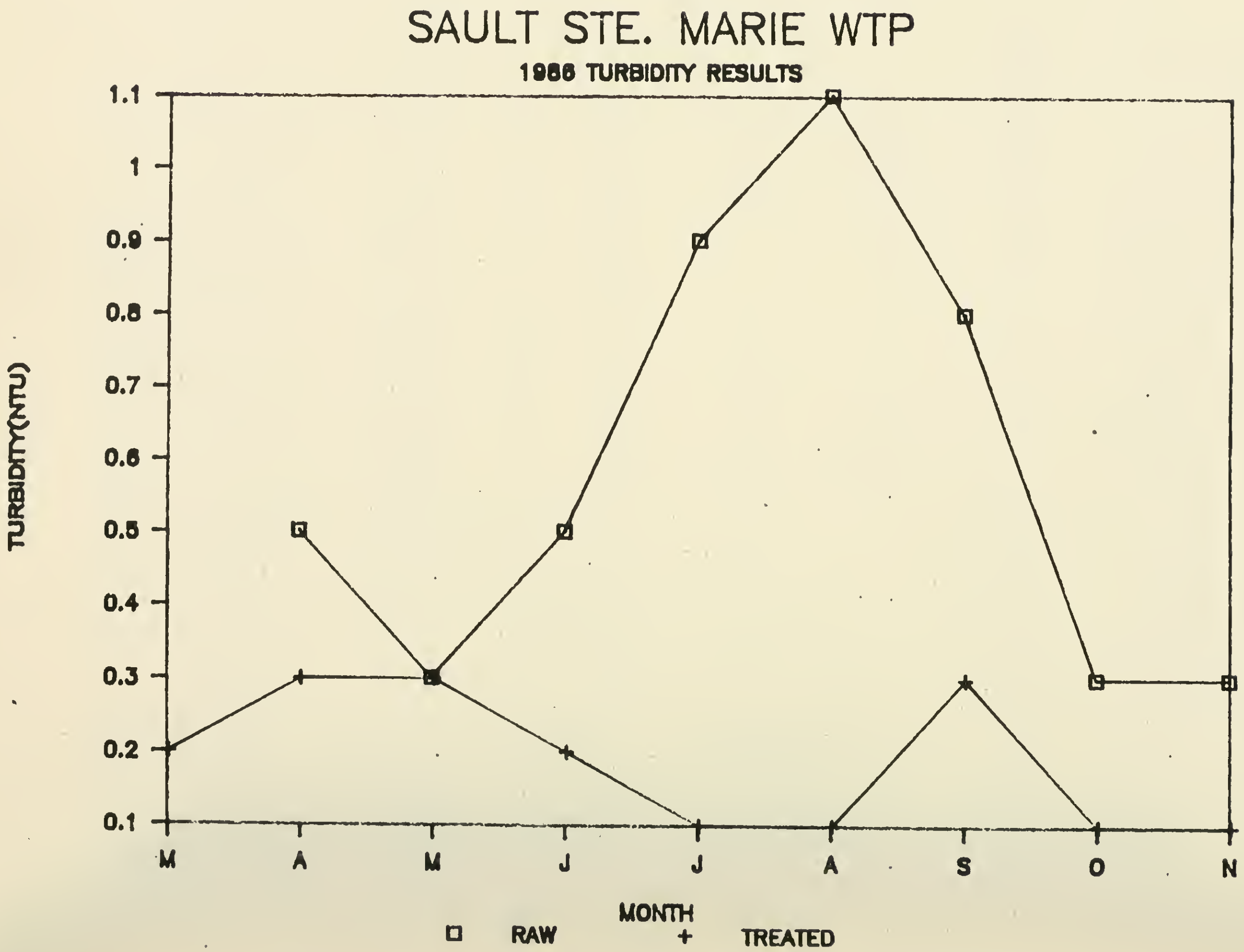
To achieve optimum removal of particulates there are several processes in the direct filtration process which must be examined for maximum performance.

These areas are:

a) Coagulation/Flocculation
b) Filtration
c) Aluminum Residuals

i) <u>Coagulation/Flocculation</u>

FIGURE 4a



SAULT STE. MARIE WTP
1986 TURBIDITY RESULTS
TURBIDITY(NTU)
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
M
A
M
J
J
A
S
O
N
MONTH
RAW
TREATED

TABLE 4b

SAULT STE. MARIE "ON-LINE" FILTER RUNS

RUN NO.	ALUM DOSAGE (mg/l)	FLOCCULATORS	PRE CL2	RAW TURBIDITY (NTU)	FILTER TURBIDITY (NTU)							
					FILTER 1	FILTER INDEX	FILTER 2	FILTER INDEX	FILTER 3	FILTER INDEX	FILTER 4	FILTER INDEX
1	6	S	0.7	0.4	.07	114			.07	260		
2	2	S	0.7	0.4-0.3			0.18	-			0.21	1080
3	2	P	0.7	0.3-0.4	0.19	660			0.19	1320		
4	2	P	0.3	0.3			0.19	1980			0.21	1320
5	2	S	0.35	0.3	0.2	1320			0.2	990		
6	4	S	0.7	0.3			0.13	220			0.14	150
7	4	P	0.7	0.3	0.10	124			0.10	165		
8	4	P	0.35	0.3			0.11	140			0.11	120
9	4	P	.35	0.3	0.12	165			0.10	141		
10	6	P	0.7	0.2			0.31	313			0.24	155

NOTE: S=SERIES , P=PARALLEL

FIGURE 4c

SAULT STE. MARIE

FILT. PERFORMANCE (@ 12m/hr,ALUM 6mg/l)

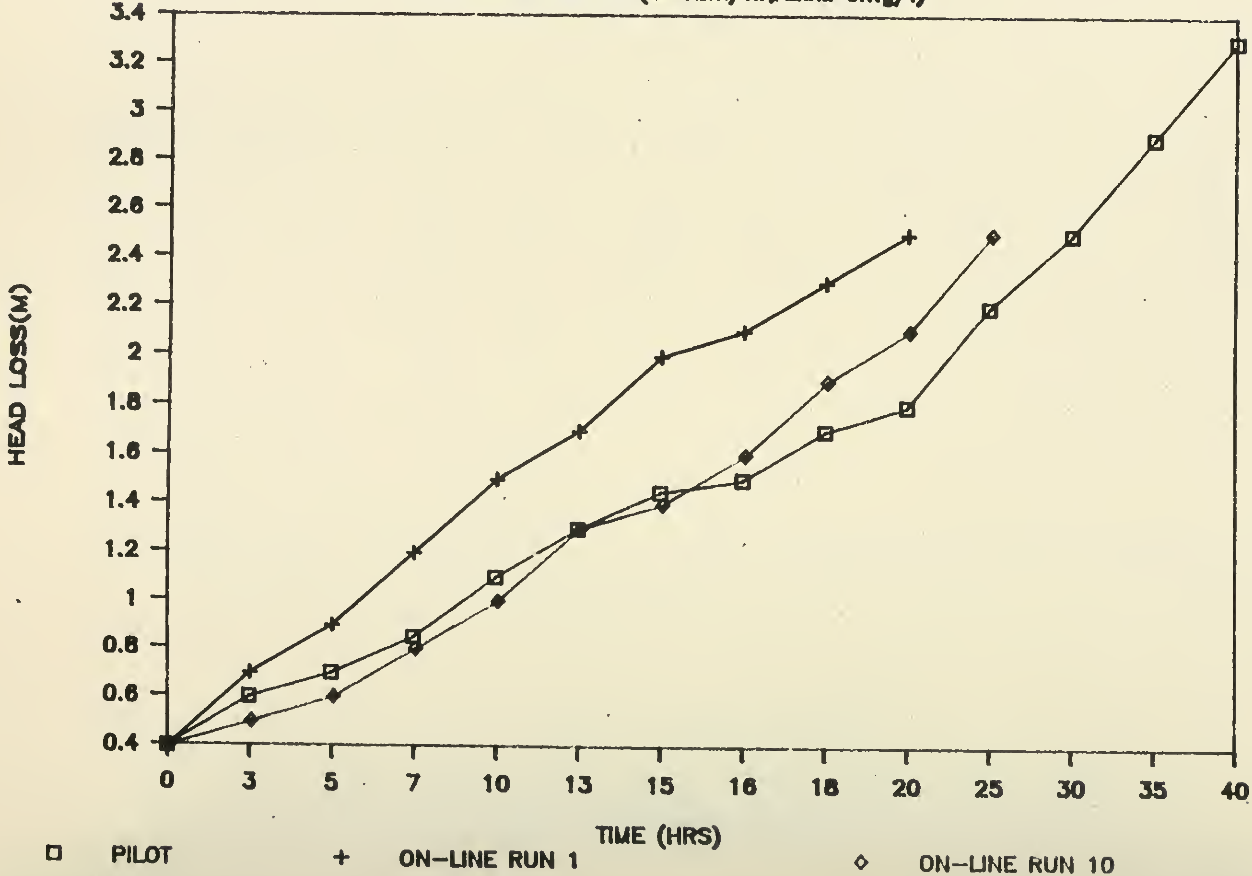
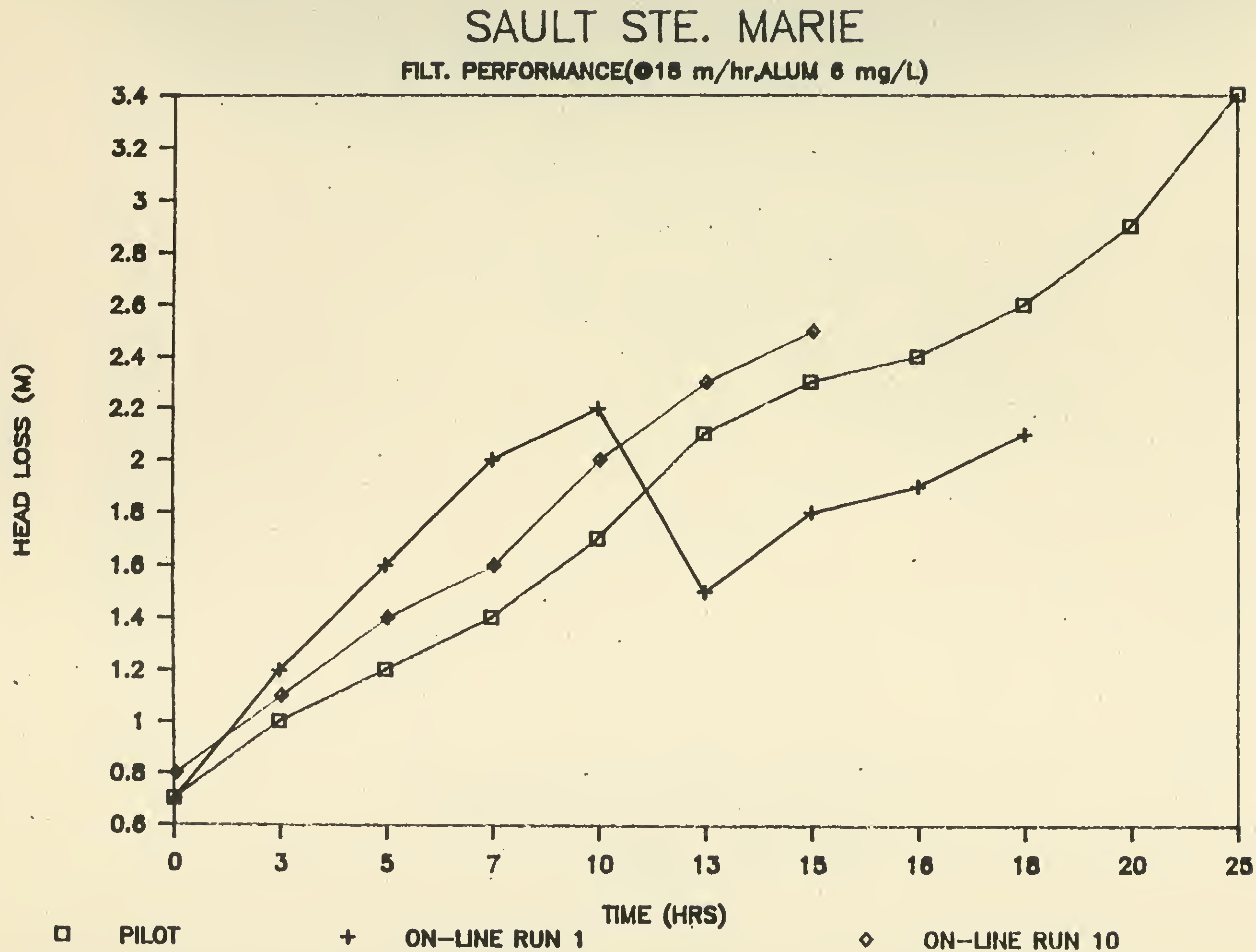


FIGURE 4d



SAULT STE. MARIE
FILT. PERFORMANCE(@18 m/hr,ALUM 6 mg/L)
HEAD LOSS (M)
3.4
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0
3
5
7
10
13
15
16
18
20
25
TIME (HRS)
PILOT
ON-LINE RUN 1
ON-LINE RUN 10

FIGURE 4e

SAULT STE. MARIE

FILT. PERFORMANCE (@ 12m/hr,ALUM 4mg/l)

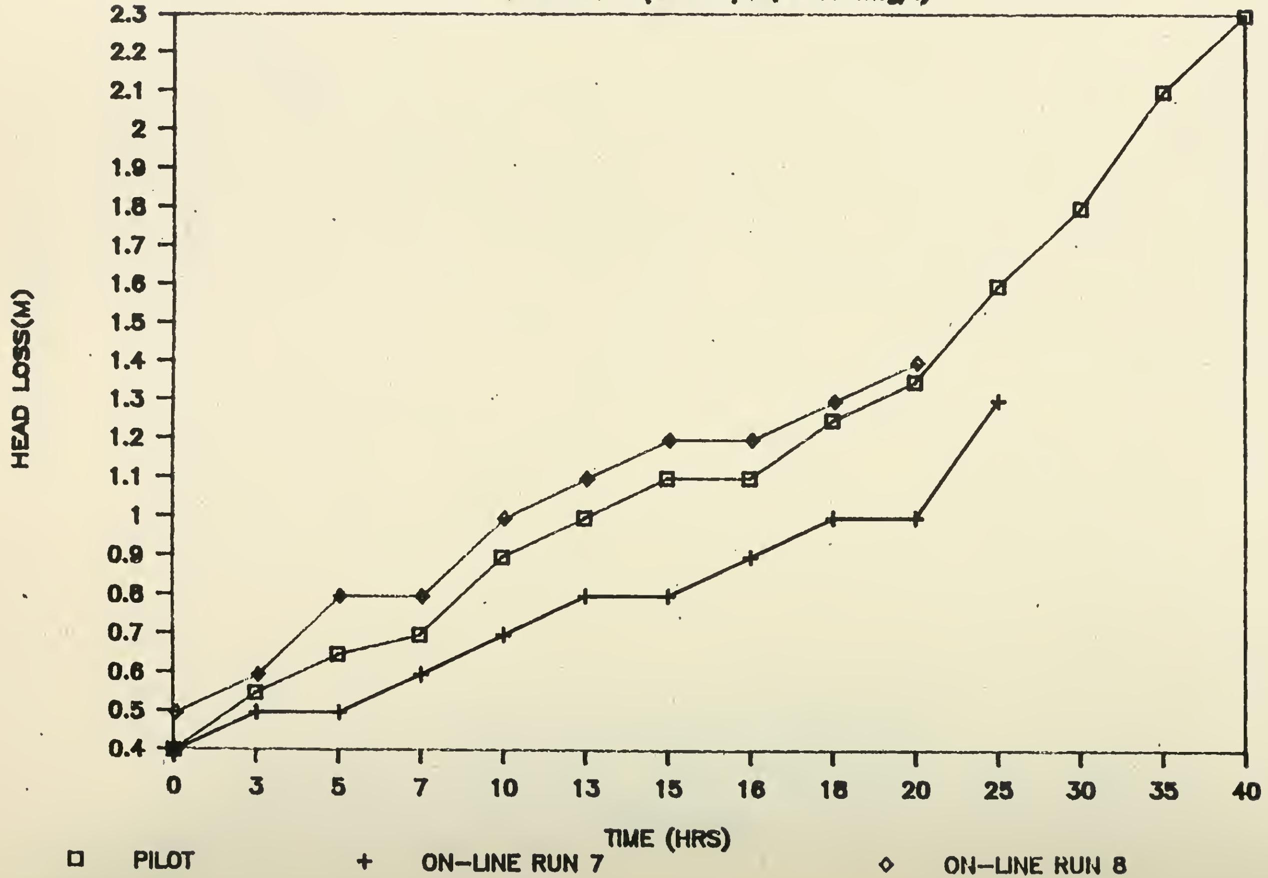
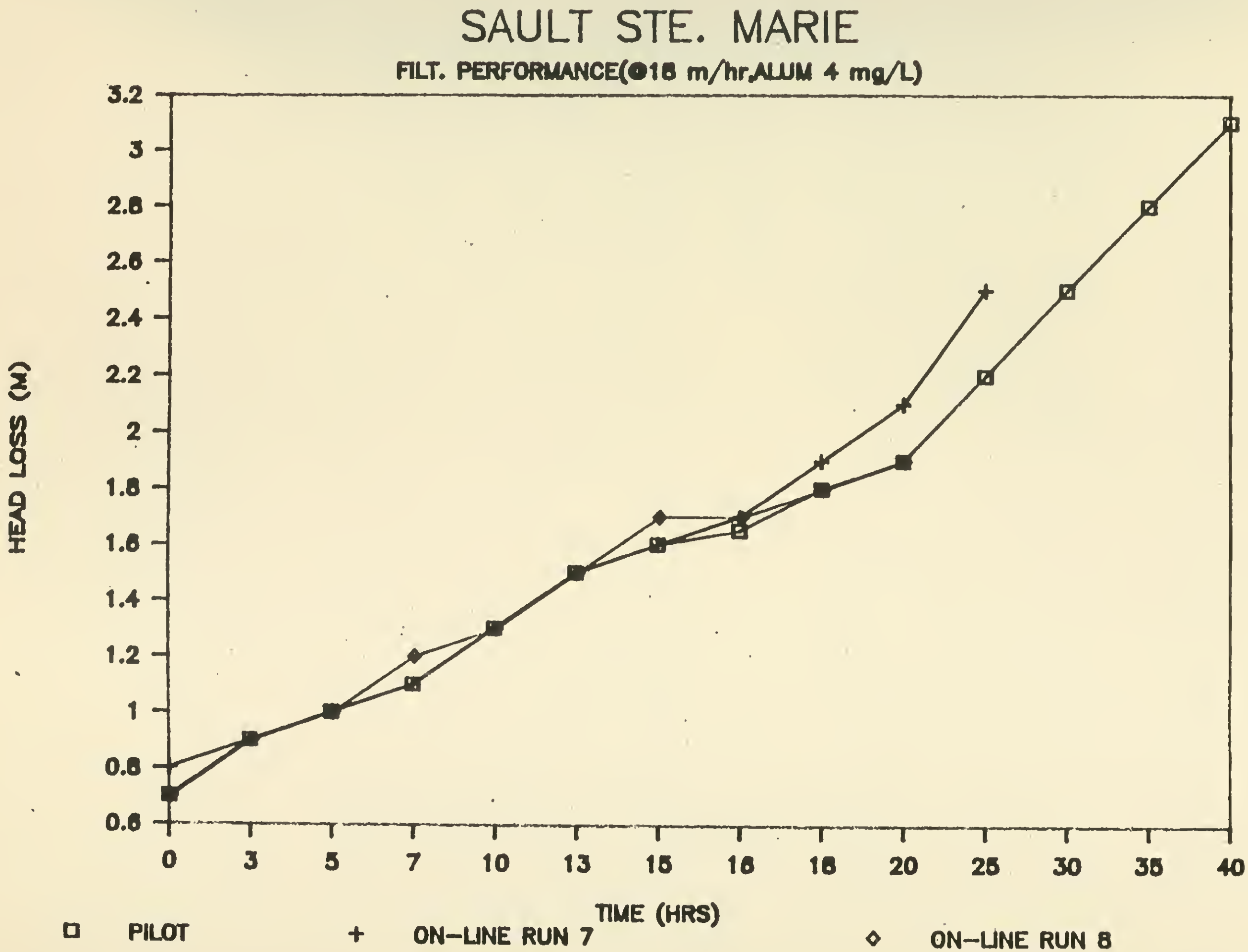
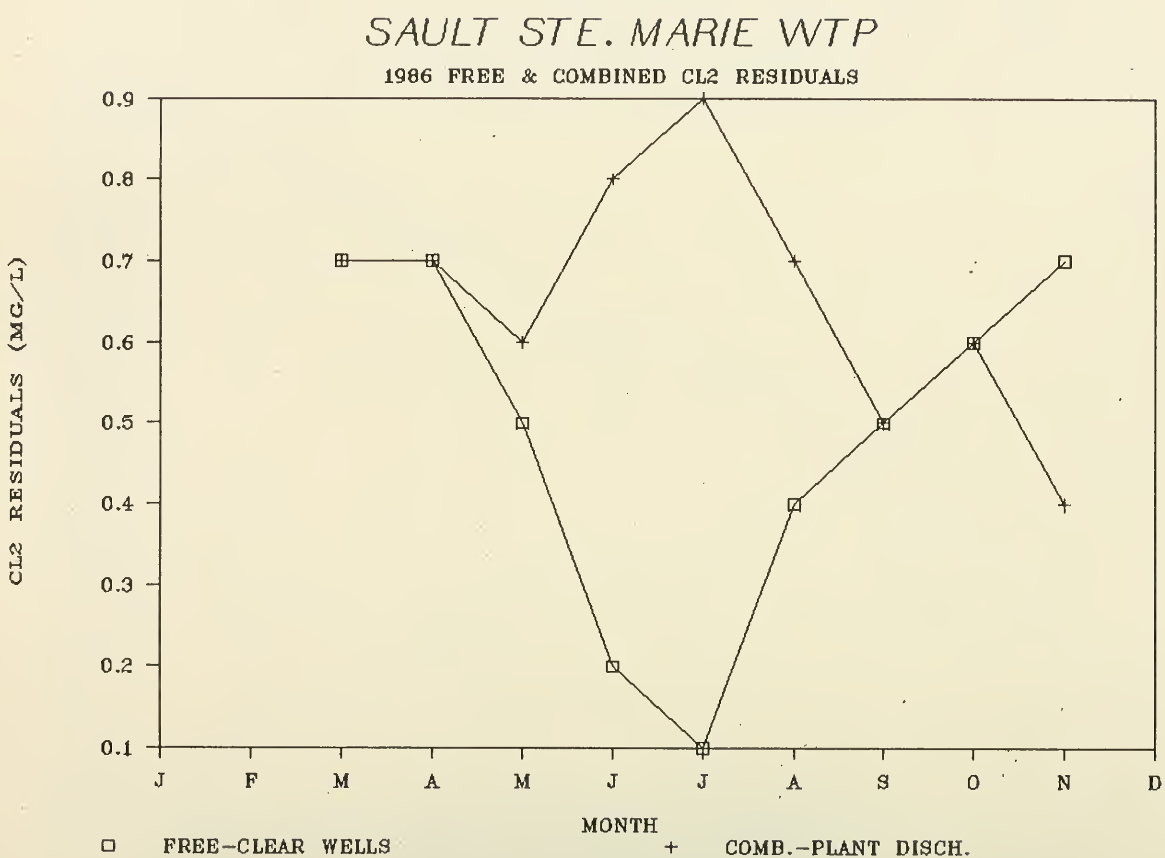


FIGURE 4f



SAULT STE. MARIE
FILT. PERFORMANCE(@16 m/hr,ALUM 4 mg/L)
HEAD LOSS (M)
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0
3
5
7
10
13
15
16
18
20
25
30
35
40
TIME (HRS)
PILOT
ON-LINE RUN 7
ON-LINE RUN 8

Figure 4q



SAULT STE. MARIE WTP
1986 FREE & COMBINED CL2 RESIDUALS
CL2 RESIDUALS (MG/L)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
J F M A M J J A S O N D
MONTH
□ FREE-CLEAR WELLS
+ COMB.-PLANT DISCH.

It is recognized that flocculation is necessary for effective removal of turbidity in a water treatment plant and that this is the area to which most attention should be given in order to optimize particulate removal.

The plant tests carried out at the Sault Ste. Marie Treatment plant have shown that alum is a suitable and effective coagulant. The optimum dosage for the plant is between 2 and 6 mg/l. At dosages between 2 and 4 mg/l, there seems to be little difference in operating the flocculators in series or parallel. However, when the dosage of alum is increased to 6 mg/l, the flocculators should be operated in series in order to provide tapered flocculation and maximum available energy for hydrolysis and complexation and therefore reduce the turbidity to the minimum achievable.

ii) <u>Filtration</u>

The final means of removal of particulates in any plant is by filtration. There are several ways by which filtration may be improved. At the Sault Ste. Marie plant, filtration consists of four dual media filters. The current anthracite layer is 550 mm deep with an e.s. of 0.90 and a u.c. of 1.38. If this layer was of finer grade anthracite or of greater depth, then the quantity of particulates entrapped in the filter would be increased. This, of course, is contingent on achieving deep bed filtration. At the same time filter headloss would increase at a faster rate and the filter runs would be decreased. The current plant runs can last 72 hours; there would be no problem in reducing them to 24 hours. However there is no guarantee that this would improve the current high quality of the water.

During the original pilot plant study, higher water treated turbidities were encountered during cold water conditions. Due to this condition, it is recommended that Polyaluminum Chloride (PACL) be run on a pilot plant scale to determine the rates required to achieve lower turbidity levels during cold water periods.

During the worst water quality conditions, the finished water is still considerably better than the best quality of many plants. The plant can easily reduce water of 1.1 NTU turbidity to 0.1 NTU. (This factor alone demonstrates how well the plant is operated.)

iii) <u>Aluminum Residual In Finished Water</u>

The use of aluminum salt coagulants (alum, polyaluminum chloride, etc.) in potable water treatment plants may lead to increased concentrations of aluminum in the treated water, and these may result in water quality and supply problems. At present, there is no evidence that aluminum is physiologically harmful and no health-related limit has been specified anywhere in the world to our knowledge. However, the perception of potential health problems associated with aluminum frequently emerges.

Water supply problems may be associated with increased aluminum concentrations in treated water. These problems include the formation of a hydrous aluminum precipitate in the distribution system (which may increase turbidity and complaints about clarity) and the deposition of aluminum hydrolysis products on pipe walls (thus decreasing flow capacity). Aluminum floc in the system may also interfere with the disinfection process by entrapping and protecting microorganisms. To minimize these problems, the Ontario Drinking Water Objectives suggest an operational guideline of less than 0.1 mg/l as Aluminum in the treated water leaving the plant.

A survey by the United States Environmental Protection Agency of 186 utilities showed that a number of plants exhibited high residual aluminum when overdosing of alum occurred. Even though some utilities surveyed stated that minimizing the alum dosage is a strategy for controlling residual aluminum, underdosing of alum appears to be just as detrimental to turbidity removal and residual aluminum control as overdosing.

Water quality problems associated with high concentrations of aluminum in finished water have led to discussion of ways to reduce residual aluminum concentrations. One method of reducing aluminum concentration is to optimize coagulation. To have optimum coagulation requires that the best coagulant, dosage and combination of operating conditions be selected for each raw water. The optimum pH range must also be achieved since aluminum is least soluble in water in the pH range 5.5-7.0.

There are treatment plants in Ontario which are currently using residual aluminum as an "operating tool" to optimize the dosage of alum. Operational staff respond to any elevation in residual aluminum and make the necessary adjustments to the plant operation.

A minimum of daily monitoring of aluminum residual and pH leaving the plant is recommended. Frequent examination of this data and Drinking Water Surveillance Program (DWSP) data will supply the needed information on the chemistry and fate of aluminum following water treatment to help operating authorities minimize the concentration of aluminum in the treated water.

The Sault Ste. Marie PUC has advised that aluminum residuals are currently in the 0.110 to 0.125 mg/l range. (Higher residuals are noted in the operating data included in Tables 2.0 and 2.1, however these occurred during the plant start-up. They were due to initial metering pump malfunctions, which have been rectified). These current values exceed the guidelines and plant staff are reviewing alternative coagulant options to reduce these levels.

E.1.2 GROUNDWATER SUPPLY

a) <u>Plant Performance</u>

As stated in the previous section, the supply to the distribution system in Sault Ste. Marie is supplemented by several wells situated in the east and west parts of the city. There are a total of six wells in four locations, Lorna Drive, Shannon Drive, Steelton Drive and Goulais Avenue. The water quality from these wells in terms of turbidity is good, ranging from 0.02 to 0.26 NTU. No treatment for turbidity is carried out at any of these wells. The only treatment that is carried out is disinfection and this has no bearing on turbidity values.

b) <u>Treatment</u>

Possible treatment of the wells was not investigated since the groundwater quality meets guidelines with respect to water quality and the treatment of groundwater.

c) <u>Wells</u>

For treatment (i.e. turbidity/particulate removal) of the well water, a treatment plant would be required. Due to the current reserve capacity at the water treatment plant, the good quality of the groundwater and the capability of expanding the plant, groundwater treatment would not be seriously considered.

E.2 DISINFECTION

a) <u>General</u>

Disinfection is defined as a treatment that destroys harmful microorganisms including bacteria and viruses. Current available methods include chemical and non-chemical means of treatment. Unfortunately, chemicals that are capable of destroying bacteria are usually powerful interactive compounds which can combine with organic compounds present in the water. Of the chemicals applied

for water disinfection, chlorine is the most widely used. .However, research on chlorine has shown that by-products are formed when chlorine is used on water containing elevated dissolved organic carbon and/or high levels of colour. Some of these by-products may be hazardous to health in the long term and therefore it is considered important to minimize the formation of these products. This means that water treatment plants should maintain proper disinfection of the water with the minimum formation of disinfection by-products.

E.2.1 SURFACE WATER SUPPLY

a) <u>Measurement System</u>

The chlorine residual in the water leaving the treatment plant is currently measured by a Wallace and Tiernan A-773/A-780 analyser. This meter is situated between Clearwell 1 and 2 and draws a composite sample for free chlorine residual analysis. The plant discharge is analysed for combined chlorine at the high lift pump discharge header. The combined chlorine residual leaving the plant is continuously logged and the current value is displayed in the control room. The combined chlorine residual is measured by a Wallace and Tiernan A-790 Chlorine Residual Titrator. Free chlorine residual is measured from grab samples from the backwash holding tanks. Although continuous monitoring equipment exists at this location, it did not operate reliably under the intermittent flow conditions that exist.

Little bacteriological data in the distribution system exists from the study period due to the fact that bacteriological testing was done by the Algoma Health Unit. Results were only reported to the Sault Ste. Marie PUC in the rare event that a problem was indicated. This, along with some apparent inconsistencies in chlorine residuals, left some question as to the effectiveness of the disinfection process.

Recently the PUC assumed responsibility for conducting bacteriological sampling and testing. In addition to sampling undertaken at the water treatment plant and wells, 65 - 80 samples are taken during each month from seventeen locations in

the distribution system. Testing of the samples is done in the Sault Ste. Marie laboratory of the Ministry of Health and all results reported to the PUC.

The results of this testing for 1990 are reported in Table 6. These results show only one sample with only one total coliform count in 1990, suggesting that the disinfection process is satisfactory. The number of samples should, however, be maintained at 82 per month in accordance with the guidelines suggested in the Ontario Drinking Water Objectives for a City with a population of 74,000.

b) **<u>Disinfection Efficiency</u>**

The 1986 maximum treatment plant raw water total coliform and fecal coliform results were 30 and 2 counts per 100 ml. respectively, with average values of 0.13 and 0.04 per 100 ml. Minimum counts were zero in both cases. Initial data on water leaving the plant during plant start-up showed some Fecal Coliform counts as shown in Table 6.0. While specific reasons for this is not known, all subsequent data shows values of zero.

The free chlorine residuals measured at the clearwells are generally above 0.1 mg/L, (see Figure 4g). The total chlorine residuals were usually around 1 mg/L during 1986, with the combined chlorine rising in summer while free chlorine levels drop. The plant therefore maintains its disinfection capacity throughout the year. Provision has also been made for pre-chlorination at the Gros Cap intake, although it is currently practised only at the low lift wet wells at the treatment plant itself. This method of disinfection, combined with the residence time in the low lift wet wells, ensures that the water reaching the plant unit processes is thoroughly disinfected.

Filtered water is disinfected upstream of the clearwells, and ammonia is added at the plant discharge main, to provide chloramination and a longer lasting combined residual into the distribution system.

Water pH and temperature have an effect on the efficiency of the disinfection process, by affecting the percentage of hypochlorous acid in the equilibrium

reaction with the hydrogen and hypochlorite ions. Hypochlorous acid is the more powerful disinfectant, and its undissociated percentage decreases as pH and temperature increase.

At the Sault Ste. Marie treatment plant, the pH is frequently in the 8.0 range, and temperatures as high as 22°C are experienced. Under these conditions, approximately 25% undissociated hypochlorous acid is present. At 5°C, the figure rises to 36%.

This dissociation is an equilibrium reaction, so the percentage presence of HOCL will be maintained. At the present time, there is no evidence that the disinfection process at the Sault Ste. Marie plant or wells is inefficient, and sufficient contact time is available to permit adequate disinfection to occur.

Plant staff must, however, be mindful of the potential for decreased disinfection efficiencies at times of increased pH and temperature.

c) **Chlorinated By-Product Formation**

As noted previously, pre-chlorination is currently practiced at the Sault Ste. Marie plant itself, with provision for chlorination at the raw water pumping station at Gros Cap 10.8 km away. If the pre-chlorination is practiced at Gros Cap the long residence time in the pipe and control tanks may allow for the formation of halogenated organics. This should be studied prior to implementing such procedures. Both the colour and the dissolved organic carbon in the raw water are low, at 2 TCU and 1 - 2 mg/L respectively. Based on these findings, we believe that the disinfection at the plant produces levels of chlorinated by-products well below current MOE guidelines. This could be confirmed by checking the total trihalomethane formation potential of the raw water.

The current prechlorination level of 0.4 mg/L, ensures favourable conditions for little or no formation of halogenated organics.

Ammonia is added after treatment, but prior to the water being fed into the distribution system.

Current Total Trihalomethane (TTHM) levels at the treatment plant are less than 0.02 mg/l (from DWSP data), well below the 0.35 mg/l guideline.

E.2.2 GROUNDWATER SUPPLY

a) Measurement System

The wells are monitored on a daily basis for combined chlorine residual using the DPD method. The DPD method of analysis is used for chlorine measurements. This is a fast simple method of analysis, however, it is also a method prone to bias since it is a visual method. Generally, the results are shown as 0.45 to 0.60 mg/L of combined chlorine, since the device shows no intermediate readings between these two levels. It is unlikely that this level of accuracy is attained using the DPD method and the results in Table 3.0 should be recorded to no more than one decimal place to reflect the inherent errors.

b) Disinfection Efficiency

The groundwater is chlorinated and is tested for bacteriological contamination on a daily basis from Monday to Friday. The samples are passed to the Ministry of Health laboratories who alert the PUC if any positive results are found. In each case, where a positive has been found, resampling has shown the problem to be intermittent or more likely due to bottle contamination. In conjunction with chlorine residuals between 0.4 and 0.6 mg/L, it appears that the well water is adequately disinfected.

c) Chlorinated By-Product Formation

At the wells, ammonia is added to the water prior to chlorine. This prevents the formation of chlorophenols in the water, since phenol is known to be present in the west end wellwaters. Such a chemical dosing system ensures that little or no

halogenated organics form in the well water and in particular that no chlorinated phenolics are formed from the phenols present in the Steelton and Goulais well waters . It should be noted that no other precursors are present.

DWSP data since the study period shows TTHM levels below detection limits at the Steelton and Lorna wells (based on monthly sampling).

SECTION F - SHORT TERM MODIFICATIONS

SECTION F   SHORT TERM MODIFICATIONS

F.1   SURFACE WATER SUPPLY

The water treatment plant at Sault Ste. Marie has only been in operation for a short period, but experience to date indicates that it is capable of providing water of excellent quality. The water treatment plant raw water quality would need to undergo degradation or high fluctuations to permit a full assessment under all conditions. The chemicals used are still being investigated. Alum alone is utilized at 2 - 4 mg/L and there seem to be no problems with its use or its ability to treat all incoming water. Experimentation with alternate coagulants such as polyelectrolytes and polyaluminum chloride should, however, be undertaken, particularly to reduce aluminum residuals. The following points have been noted as areas where improvements may enhance particulate removal.

- Study the use of alternative coagulants such as polyelectrolytes and polyaluminum chloride and different aluminum sulphate dosages, including the effect on aluminum residuals.

- Remove dead areas at the end of the flocculator inlet and outlet channels and at the end of the filter influent channels.

- Add a streaming current meter and control equipment in order to control coagulant dosages, particularly if raw water quality fluctuations are experienced.

- Develop an accurate means of calibrating and correlating turbidimeters.

- From observations during plant inspections, it would be advisable to set-up a schedule of laboratory tests to be done on a daily basis such as raw water colour, flocculated water colour and aluminum residual, filter effluent colour and aluminum residual.

The following points have also been noted:

It would be advisable to set-up quarterly measurements of media depth and a program to perform sieve analysis within the next two to three years. The headloss through the bed should also be monitored. This could be done by installing monitoring points through the filter at several points, especially at the sand/anthracite filter interface. Another means of monitoring filter bed loss is by sampling the sludge periodically to detect loss of media.

Experimentation with wash rate duration has not been done at the plant. This would require a program to be set-up to monitor bed performance and particulate matter accumulation within the bed. Improved filter efficiency based on unit production/backwash water used could be only recommended based on no deleterious effects on water quality.

An accurate accounting and recording of coagulant usage and dosage should be implemented. This could be achieved by providing continuous readings of level in both aluminum sulphate storage vessels and performing the required calculations in the central computer (similar to chlorine, aqua ammonia and sulfur dioxide measurement and dosage calculations).

As discussed in earlier sections, the method of ammoniation at the treatment plant is by using aqua ammonia, whereas the wells previously used an anhydrous system requiring softened water to operate the ammoniators. All anhydrous systems have been converted to aqua ammonia at the wells, thereby eliminating the need for softened water.

It is also recommended that analysis for halogenated organics be continued at all sources, but especially at the treatment plant. Such analysis was lacking in data available during the study period. Subsequent to this study, DWSP information has become available. Using the present prechlorination techniques, the potential for TTHM formation is low.

F.2 GROUNDWATER SUPPLY

The Lorna well requires periodic shock treatment with chlorine due to biological activity. As such is the case, the screens at the well should be reviewed for structural integrity due to possible attack from high levels of chlorine.

A short term recommendation would be to consider the installation of a continuous residual analyser to monitor and remotely log the combined chlorine residual at each of the wells. This will remove the reporting inaccuracies inherent in the current DPD method.

F.3 GENERAL

a) Record Keeping

Record keeping for both the Sault Ste. Marie Water Treatment Plant and well systems is now centralized in the computer system at the Treatment Plant. Samples of the daily log sheets are included in this report as Appendix B.

Most of the data used in preparing the Tables in the Appendices to this report precedes this centralized system, and some discrepancies and omissions were identified. In order to ensure the integrity and accuracy of ongoing data and record keeping, the following recommendations are made:

- The computer generated reports should be checked regularly for obvious omissions or discrepancies in automatically logged data. An error or comment report could then be generated until the cause is determined and the problem resolved.

- Care should be taken not to report results to a greater accuracy than the analytical instrument can achieve. This is particularly true of the measurement of chlorine residuals using a DPD Comparator. In this study, the consistency of the reported numbers initially led to a concern over the actual frequency of the testing. It was also discovered that in

some cases the chlorine residual reported (from the comparator) exceeded the dosage (calculated from recorded chemical usage).

The actual reporting of a residual range, and a notation on the records as to the reason will help resolve these particular uncertainties.

- Where reporting is by exception, such as in the case of bacteriological testing, the actual performance of the sampling and testing should be reported, even if the detailed results are not (when all are negative). This will ensure the actual sampling is being performed.

Overall, therefore, automatically logged data should be checked for consistency, and discrepancies noted and investigated.

b) <u>Bacteriological Testing</u>

It is recommended that bacteriological data be reviewed on a daily basis and tabulated with chlorination and pH data. This will enable quick correlations between bacteriological positive results and low disinfection levels.

The frequency of bacteriological sampling in the distribution system should be maintained at 82 samples per month in accordance with the Ontario Drinking Water Objectives.

SECTION G - LONG TERM MODIFICATIONS

SECTION G LONG TERM MODIFICATIONS

Due to the short time the plant has been in service, and its level of performance, both in terms of throughput and finished water quality, no long term modifications are recommended from this study.

APPENDIX A

TABLES

TABLE 1

WATER PLANT OPTIMIZATION STUDY
"PLANT FLOWS"

TABLE 1.0: GOULAIS WELLS, SAULT STE. MARIE
FLOWS (ML/d)

MOE WPOS PROTOCOL

		1986			1985			1984			1983		
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG
JAN	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	9.48	9.21	9.33	9.19	8.60	9.05	9.22	8.89	9.16	9.25	9.08	9.15
FEB	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	9.35	0.00	6.56	9.37	9.11	9.29	9.22	9.06	9.16	9.43	9.02	9.25
MAR	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	9.56	2.11	8.31	9.43	9.27	9.35	9.16	8.89	9.05	9.44	9.11	9.28
APR	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	9.27	1.59	5.43	9.52	8.96	9.35	9.18	8.78	9.11	9.57	9.11	9.44
MAY	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	9.91	0.00	5.29	9.39	9.18	9.29	9.22	9.07	9.14	9.52	9.16	9.23
JUN	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	9.16	2.48	5.61	9.31	9.10	9.23	9.21	8.74	9.09	9.21	9.10	9.16
JUL	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	9.24	3.50	6.51	9.32	9.20	9.26	9.10	9.03	9.06	9.22	8.68	9.13
AUG	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	7.15	2.24	3.95	9.31	8.92	9.20	9.10	8.98	9.05	9.20	8.59	9.10
SEP	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	9.29	0.51	4.23	9.21	9.10	9.16	9.16	6.92	8.98	9.14	8.47	9.09
OCT	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	9.20	7.90	8.83	9.57	8.83	9.16	9.42	8.76	9.05	9.47	9.08	9.13
NOV	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	9.22	2.62	7.70	9.23	9.03	9.17	9.08	8.99	9.06	9.22	9.03	9.12
DEC	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	–	–	–	9.42	7.79	9.00	9.09	8.87	9.00	9.18	8.40	9.12

TABLE 1.0: LORNA WELLS, SAULT STE. MARIE
FLOWS (ML/d)

MOE WPOS PROTOCOL

		1986			1985			1984			1983		
		MAX	*MIN*	*AVG*	*MAX*	*MIN*	*AVG*	*MAX*	*MIN*	*AVG*	*MAX*	MIN	AVG
JAN	*R*	–	–	–	–	–	–	–	–	–	–	–	–
	T	13.46	2.84	11.22	13.27	4.92	9.30	13.63	4.57	9.20	7.42	6.72	7.07
FEB	*R*	–	–	–	–	–	–	–	–	–	–	–	–
	T	13.41	0.20	7.61	13.93	4.59	11.13	13.63	6.27	11.48	14.31	2.70	9.83
MAR	*R*	–	–	–	–	–	–	–	–	–	–	–	–
	T	18.84	0.00	7.58	13.89	8.57	11.90	13.90	5.56	11.63	14.09	6.58	9.97
APR	*R*	–	–	–	–	–	–	–	–	–	–	–	–
	T	12.40	0.00	4.95	13.96	6.04	12.25	13.04	6.92	11.69	14.23	0.00	8.15
MAY	*R*	–	–	–	–	–	–	–	–	–	–	–	–
	T	13.31	1.11	9.08	8.73	3.23	6.36	12.76	7.80	11.37	7.03	6.94	6.97
JUN	*R*	–	–	–	–	–	–	–	–	–	–	–	–
	T	12.20	0.00	4.59	7.15	6.63	6.84	12.83	3.54	11.48	13.90	6.32	9.20
JUL	*R*	–	–	–	–	–	–	–	–	–	–	–	–
	T	13.33	0.00	6.85	6.87	6.49	6.68	10.04	0.00	7.03	14.17	11.26	13.53
AUG	*R*	–	–	–	–	–	–	–	–	–	–	–	–
	T	9.54	0.00	2.45	13.60	5.72	8.15	13.43	0.00	9.49	14.10	6.07	10.20
SEP	*R*	–	–	–	–	–	–	–	–	–	–	–	–
	T	7.54	0.00	1.59	13.97	0.00	10.36	13.78	0.00	9.24	13.77	6.10	11.74
OCT	*R*	–	–	–	–	–	–	–	–	–	–	–	–
	T	7.63	0.00	3.59	13.08	5.42	11.50	13.07	6.41	8.54	14.12	11.94	13.54
NOV	*R*	–	–	–	–	–	–	–	–	–	–	–	–
	T	10.18	0.00	5.23	13.25	6.36	10.98	10.84	6.41	7.36	13.68	4.19	8.78
DEC	*R*	–	–	–	–	–	–	–	–	–	–	–	–
	T	–	–	–	13.25	7.57	11.39	13.21	6.42	9.04	13.57	6.09	8.58

TABLE 1.0: SHANNON WELL, SAULT STE. MARIE FLOWS (ML/d)

MOE WPOS PROTOCOL

		1986			1985			1984			1983		
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG
JAN	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	6.99	4.24	6.48	7.02	4.99	6.68	6.84	6.56	6.71	7.18	4.59	6.97
FEB	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	6.81	0.00	5.10	6.93	5.20	6.43	6.66	6.46	6.56	7.30	6.49	6.79
MAR	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	6.81	0.00	4.71	7.16	6.13	6.40	6.86	4.55	6.46	7.15	5.50	6.79
APR	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	11.28	0.00	3.85	6.86	6.04	6.47	6.79	5.95	6.62	7.18	1.09	6.48
MAY	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	7.10	0.00	2.45	7.09	6.72	6.95	6.94	6.33	6.73	7.16	6.39	6.92
JUN	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	9.48	0.00	4.13	7.28	6.76	7.04	6.86	4.59	6.50	7.20	5.13	6.76
JUL	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	7.06	0.00	2.16	7.17	6.29	6.79	7.53	6.84	7.04	6.79	4.80	6.49
AUG	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	7.11	0.00	4.17	6.85	5.60	6.69	7.54	4.09	6.38	7.20	5.32	6.67
SEP	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	5.34	0.00	1.00	7.43	0.28	6.26	7.95	0.00	4.98	7.25	5.08	6.52
OCT	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	7.21	0.00	2.64	7.14	5.18	6.55	7.45	4.79	6.87	6.62	5.64	6.34
NOV	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	7.26	0.00	2.33	7.06	4.68	6.62	7.16	5.07	6.70	7.08	1.25	6.11
DEC	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	-	-	-	7.04	4.24	6.61	8.55	4.52	6.71	6.80	3.17	6.37

TABLE 1.0: STEELTON WELL, SAULT STE. MARIE
FLOWS (ML/d)

MOE WPOS PROTOCOL

		1986			1985			1984			1983		
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG
JAN	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	8.17	0.00	0.41	8.28	7.56	8.01	8.23	7.70	8.14	8.33	7.80	8.19
FEB	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	8.17	0.00	7.30	8.14	7.72	7.87	8.30	8.04	8.12	8.33	8.06	8.16
MAR	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	8.48	0.00	7.90	8.21	7.80	8.15	8.24	8.08	8.16	8.27	8.04	8.15
APR	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	9.05	8.35	8.58	8.33	7.77	8.07	8.21	8.06	8.11	8.29	7.85	8.19
MAY	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	9.82	8.69	9.07	8.08	7.65	7.96	8.16	8.05	8.12	8.28	8.13	8.21
JUN	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	9.28	8.85	9.08	7.87	7.24	7.76	8.25	7.99	8.09	8.27	8.03	8.17
JUL	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	9.26	8.80	9.03	8.09	7.73	7.83	8.14	0.01	7.79	8.28	7.95	8.11
AUG	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	9.31	9.03	9.19	7.96	7.19	7.80	8.12	7.91	8.01	8.19	7.96	8.08
SEP	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	9.41	0.00	4.78	8.31	7.46	7.90	8.22	7.99	8.08	8.14	7.98	8.06
OCT	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	0.01	0.00	0.00	8.33	7.95	8.05	8.61	7.79	8.12	8.48	7.74	8.11
NOV	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	10.02	0.00	2.46	8.11	7.95	8.05	8.25	8.11	8.20	8.35	7.72	8.14
DEC	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	-	-	-	8.23	0.00	5.04	8.36	7.82	8.18	8.22	8.13	8.17

TABLE 1.0: SAULT STE. MARIE, TOTAL WELL PRODUCTION FLOWS (ML/d)

MOE WPOS PROTOCOL

		1986			1985			1984			1983		
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG
JAN	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	42.84	21.02	29.67	36.87	29.37	33.03	37.53	28.48	33.37	34.04	27.42	32.21
FEB	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	36.90	21.95	27.17	37.40	28.77	35.53	37.52	30.37	34.96	40.20	26.22	29.13
MAR	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	37.37	16.93	28.67	39.24	33.01	35.80	37.50	29.31	35.30	39.39	28.25	34.20
APR	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	35.39	16.49	22.65	41.81	29.25	36.14	38.78	30.10	35.53	38.49	18.72	32.26
MAY	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	41.29	15.37	26.17	35.50	27.39	31.32	40.99	31.77	35.35	32.21	28.95	31.32
JUN	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	31.88	16.65	23.41	35.06	30.39	30.87	40.71	29.81	35.28	39.26	28.08	34.79
JUL	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	33.61	14.86	24.33	31.33	30.17	30.56	34.93	24.62	31.17	38.14	35.30	37.28
AUG	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	27.47	11.64	19.75	37.97	30.14	31.68	37.60	24.51	32.92	39.82	30.11	34.05
SEP	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	20.41	9.76	14.58	37.51	24.34	28.58	37.31	17.19	26.68	38.99	23.97	35.42
OCT	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	25.28	11.16	19.94	37.78	30.42	35.12	36.96	30.06	32.58	38.69	34.67	37.18
NOV	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	22.36	10.07	17.93	37.70	30.40	35.03	37.42	27.86	31.53	37.40	27.90	32.26
DEC	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	–	–	–	38.28	23.18	32.04	37.15	28.18	32.91	37.42	28.98	32.15

TABLE 1.0: HURON PUMPING STATION, SAULT STE. MARIE FLOWS (ML/d)

MOE WPOS PROTOCOL

		1986			1985			1984			1983		
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG
JAN	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	5.04	0.00	0.74	6.00	3.69	4.26	5.01	3.93	4.18	10.44	2.49	6.44
FEB	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	1.74	0.00	0.06	4.23	1.34	1.79	5.78	3.92	4.27	14.56	0.00	4.52
MAR	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	0.00	0.00	0.00	1.65	0.00	1.28	9.96	3.41	4.38	9.28	0.00	3.61
APR	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	0.00	0.00	0.00	8.29	0.00	2.14	5.28	3.55	4.01	16.31	0.00	5.90
MAY	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	0.00	0.00	0.00	12.38	0.00	5.96	6.10	2.78	4.20	10.90	3.36	7.11
JUN	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	0.00	0.00	0.00	19.10	2.12	7.21	16.32	3.93	6.01	28.96	6.79	12.91
JUL	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	0.00	0.00	0.00	18.85	3.75	10.41	22.44	3.25	9.63	31.04	2.94	14.01
AUG	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	0.00	0.00	0.00	17.78	1.34	8.04	22.04	3.37	7.45	18.39	0.98	11.44
SEP	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	0.00	0.00	0.00	14.81	1.36	4.82	16.61	1.23	5.64	24.00	2.04	8.50
OCT	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	0.00	0.00	0.00	4.56	1.28	2.22	4.93	3.95	4.24	8.17	0.00	3.71
NOV	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	0.00	0.00	0.00	6.75	1.18	1.58	7.03	0.00	4.27	6.91	0.00	4.24
DEC	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	–	–	–	6.35	0.00	1.09	6.64	3.86	4.27	6.71	3.59	4.47

TABLE 1.0: WATER TREATMENT PLANT, SAULT STE. MARIE, FLOWS (ML/d)

MOE WPOS PROTOCOL

		1986			1985			1984			1983		
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG
JAN	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	13.62	11.35	11.87	–	–	–	–	–	–	–	–	–
FEB	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	14.76	9.99	11.82	–	–	–	–	–	–	–	–	–
MAR	R	17.43	6.30	14.41	–	–	–	–	–	–	–	–	–
	T	14.76	2.39	11.89	–	–	–	–	–	–	–	–	–
APR	R	25.18	0.00	16.16	–	–	–	–	–	–	–	–	–
	T	17.49	0.00	13.76	–	–	–	–	–	–	–	–	–
MAY	R	18.54	9.00	13.95	–	–	–	–	–	–	–	–	–
	T	17.50	0.00	14.64	–	–	–	–	–	–	–	–	–
JUN	R	17.31	0.00	16.08	–	–	–	–	–	–	–	–	–
	T	17.55	0.00	13.35	–	–	–	–	–	–	–	–	–
JUL	R	17.90	13.51	15.90	–	–	–	–	–	–	–	–	–
	T	16.64	13.55	15.56	–	–	–	–	–	–	–	–	–
AUG	R	25.00	12.85	17.90	–	–	–	–	–	–	–	–	–
	T	17.48	13.72	15.42	–	–	–	–	–	–	–	–	–
SEP	R	25.70	19.51	23.96	–	–	–	–	–	–	–	–	–
	T	24.16	12.95	17.21	–	–	–	–	–	–	–	–	–
OCT	R	27.24	17.88	23.94	–	–	–	–	–	–	–	–	–
	T	25.73	18.93	23.53	–	–	–	–	–	–	–	–	–
NOV	R	26.68	16.93	20.68	–	–	–	–	–	–	–	–	–
	T	26.06	16.99	23.18	–	–	–	–	–	–	–	–	–
DEC	R	–	–	–	–	–	–	–	–	–	–	–	–
	T	–	–	–	–	–	–	–	–	–	–	–	–

TABLE 1.0: TOTAL SUPPLY (WELLS + SURFACE), SAULT STE. MARIE, FLOWS (ML/d)

MOE WPOS PROTOCOL

		1986			1985			1984			1983		
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG
JAN	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	45.40	32.37	33.71	41.22	33.21	37.29	41.60	33.12	37.55	39.17	34.89	38.65
FEB	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	45.17	35.58	38.99	39.87	32.93	37.32	41.98	34.34	39.23	41.58	36.68	38.57
MAR	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	41.37	31.14	36.70	40.85	34.56	37.07	41.69	35.14	39.68	39.39	36.21	37.81
APR	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	45.88	34.10	38.06	43.36	31.14	38.28	42.44	33.65	39.54	42.12	34.24	38.33
MAY	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	52.40	34.32	40.89	41.02	30.70	37.27	45.81	35.85	39.56	41.77	34.64	38.43
JUN	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	45.98	32.05	39.47	50.04	33.74	38.07	52.46	37.62	41.29	65.37	36.71	47.71
JUL	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	55.34	31.72	40.80	49.91	34.37	40.98	46.97	34.73	40.80	68.76	40.51	51.29
AUG	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	42.44	33.41	37.56	48.70	35.19	39.72	46.55	32.59	40.39	55.92	33.40	45.49
SEP	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	42.25	35.35	40.81	42.73	29.76	33.21	41.27	28.70	32.32	54.42	35.27	43.95
OCT	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	43.12	33.67	38.61	40.35	31.88	32.67	41.40	33.54	36.81	45.30	37.16	40.86
NOV	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	46.53	32.91	37.26	39.66	32.58	36.61	40.02	32.09	35.80	40.85	32.54	36.49
DEC	R	-	-	-	-	-	-	-	-	-	-	-	-
	T	-	-	-	41.60	32.66	37.73	41.44	32.14	37.18	40.90	34.10	36.70

Table 1.1: Per Capita Consumption (l/d/capita)

SAULT SAINT MARIE

CONSUMPTION	1986	1985	1984
Population *	81,718	82,122	82,512
Maxium Day	677	609	636
Minium Day	381	362	348
Average Day	471	453	465
Ratio MD:AD	1.44	1.35	1.37

* From Statistics Canada 1988, '84, '82 Municipal Directory

TABLE 2

WATER PLANT OPTIMIZATION STUDY
"PARTICULATE REMOVAL SUMMARY"

TABLE 2.1: PARTICULATE REMOVAL PROFILE (SAULT STE MARIE WATER TREATMENT PLANT)
MOE WPOS PROTOCOL

DATE	TURBIDITY (NTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. (Al) (mg/L)		pH		TEMP
	RAW	SET.	FILTER	TREAT.	mg/L*	mg/L	mg/L	RAW	TREATED	RAW	TREATED	(C)
03/86	-	-	0.5	0.2	-	-	-	0.003	0.350			
04/86	0.5	-	0.3	0.3	-	-	-	-	0.045	7.6	7.5	1.9
05/86	0.3	-	0.2	0.3	-	-	-	0.021	0.110	8.0	7.6	3.1
06/86	0.5	-	0.2	0.2	-	-	-	<0.005	0.017	8.0	7.5	10.0
07/86	0.9	-	0.1	0.1	-	-	-	0.012	0.074	8.1	7.7	13.5
08/86	1.1	-	0.1	0.1	-	-	-	0.026	0.640	8.1	7.4	15.3
09/86	0.8	-	0.4	0.3	-	-	-	0.003	0.013	7.3	6.7	11.5
10/86	0.3	-	0.1	0.1	-	-	-	0.010	<0.003	7.9	7.0	10.0
11/86	0.3	-	0.1	0.1	-	-	-	-	-	7.9	6.9	5.3
12/86					-	-	-					
11					-	-	-					
12					-	-	-					
13					-	-	-					
14					-	-	-					
15					-	-	-					

:: Note: The results of the treatment shown in this table were taken during the plant start up and are not indicative of consumer water quality.
* Not shown due to adjustment during start-up. Plant runs at 4mg/l dosage with little adjustment

TABLE 3

WATER PLANT OPTIMIZATION STUDY "DISINFECTION SUMMARY"

TABLE 3.0: DISINFECTION SUMMARY (GROS CAP)

Insufficient data was available to monitor the disinfection performance of the newly constructed Gros Cap water treatment plant.

TABLE 3.0: DISINFECTION SUMMARY
SAULT STE. MARIE (GOULAIS)

MOE WPOS PROTOCOL

		1986			1985			1984			1983		
		CHLORINATION			CHLORINATION			CHLORINATION			CHLORINATION		
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG
JUN	Cl2 Demand	-	-	-	-	-	-	-	-	-	-	-	-
	Cl2 Dosage	-	-	-	-	-	-	-	-	-	-	-	-
	Ammonia	-	-	-	-	-	-	-	-	-	-	-	-
	SO2	-	-	-	-	-	-	-	-	-	-	-	-
	Residual Cl2 Free	-	-	-	-	-	-	-	-	-	-	-	-
	Residual Cl2 Combined	-	-	-	-	-	-	-	-	-	-	-	-
	Residual Cl2 Total	-	-	-	-	-	-	-	-	-	-	-	-
JUL	Cl2 Demand	-	-	-	-	-	-	-	-	-	-	-	-
	Cl2 Dosage	1.17	0.35	0.61	0.39	0.25	0.34	0.40	0.25	0.37	0.45	0.20	0.34
	Ammonia	0.45	0.15	0.25	0.17	0.05	0.16	0.18	0.15	0.16	0.17	0.10	0.15
	SO2	-	-	-	-	-	-	-	-	-	-	-	-
	Residual Cl2 Free	-	-	-	-	-	-	-	-	-	-	-	-
	Residual Cl2 Combined	0.70	0.40	0.43	0.50	0.50	0.50	0.40	0.40	0.40	0.45	0.40	0.42
	Residual Cl2 Total	-	-	-	-	-	-	-	-	-	-	-	-
AUG	Cl2 Demand	-	-	-	-	-	-	-	-	-	-	-	-
	Cl2 Dosage	-	-	-	-	-	-	-	-	-	-	-	-
	Ammonia	-	-	-	-	-	-	-	-	-	-	-	-
	SO2	-	-	-	-	-	-	-	-	-	-	-	-
	Residual Cl2 Free	-	-	-	-	-	-	-	-	-	-	-	-
	Residual Cl2 Combined	-	-	-	-	-	-	-	-	-	-	-	-
	Residual Cl2 Total	-	-	-	-	-	-	-	-	-	-	-	-

Note: Residual chlorine results were obtained using the DPD method. In this method the accuracy is overstated and is only an approximation of the chlorine residual

TABLE 3.0: DISINFECTION SUMMARY
SAULT STE. MARIE (LORNA)

MOE WPOS PROTOCOL

		1986			1985			1984			1983		
		CHLORINATION			CHLORINATION			CHLORINATION			CHLORINATION		
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG
JUN	Cl2 Demand	-	-	-	-	-	-	-	-	-	-	-	-
	Cl2 Dosage	-	-	-	-	-	-	-	-	-	-	-	-
	Ammonia	-	-	-	-	-	-	-	-	-	-	-	-
	SO2	-	-	-	-	-	-	-	-	-	-	-	-
	Residual Cl2 Free	-	-	-	-	-	-	-	-	-	-	-	-
	Residual Cl2 Combined	-	-	-	-	-	-	-	-	-	-	-	-
	Residual Cl2 Total	-	-	-	-	-	-	-	-	-	-	-	-
JUL	Cl2 Demand	-	-	-	-	-	-	-	-	-	-	-	-
	Cl2 Dosage	0.98	0.20	0.41	0.69	0.49	0.60	1.46	0.45	0.62	0.37	0.19	0.31
	Ammonia	0.32	0.11	0.21	0.41	0.21	0.30	0.69	0.20	0.29	0.20	0.07	0.14
	SO2	-	-	-	-	-	-	-	-	-	-	-	-
	Residual Cl2 Free	-	-	-	-	-	-	-	-	-	-	-	-
	Residual Cl2 Combined	0.50	0.50	0.50	0.60	0.60	0.60	0.55	0.40	0.50	0.45	0.40	0.45
	Residual Cl2 Total	-	-	-	-	-	-	-	-	-	-	-	-
AUG	Cl2 Demand	-	-	-	-	-	-	-	-	-	-	-	-
	Cl2 Dosage	-	-	-	-	-	-	-	-	-	-	-	-
	Ammonia	-	-	-	-	-	-	-	-	-	-	-	-
	SO2	-	-	-	-	-	-	-	-	-	-	-	-
	Residual Cl2 Free	-	-	-	-	-	-	-	-	-	-	-	-
	Residual Cl2 Combined	-	-	-	-	-	-	-	-	-	-	-	-
	Residual Cl2 Total	-	-	-	-	-	-	-	-	-	-	-	-

Note: Residual chlorine results were obtained using the DPO method. In this method the accuracy is overstated and is only an approximation of the chlorine residual.

TABLE 3.0: DISINFECTION SUMMARY
SAULT STE. MARIE (SHANNON)

MOE WPOS PROTOCOL

		1986			1985			1984			1983		
		CHLORINATION			CHLORINATION			CHLORINATION			CHLORINATION		
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG
JUN	Cl2 Demand	-	-	-	-	-	-	-	-	-	-	-	-
	Cl2 Dosage	-	-	-	-	-	-	-	-	-	-	-	-
	Ammonia	-	-	-	-	-	-	-	-	-	-	-	-
	SO2	-	-	-	-	-	-	-	-	-	-	-	-
	Residual Cl2 Free	-	-	-	-	-	-	-	-	-	-	-	-
	Residual Cl2 Combined	-	-	-	-	-	-	-	-	-	-	-	-
	Residual Cl2 Total	-	-	-	-	-	-	-	-	-	-	-	-
JUL	Cl2 Demand	-	-	-	-	-	-	-	-	-	-	-	-
	Cl2 Dosage	1.46	0.37	0.62	0.58	0.34	0.45	0.53	0.36	0.45	0.54	0.41	0.48
	Ammonia	0.73	0.15	0.28	0.27	0.14	0.20	0.26	0.13	0.19	0.21	0.14	0.20
	SO2	-	-	-	-	-	-	-	-	-	-	-	-
	Residual Cl2 Free	-	-	-	-	-	-	-	-	-	-	-	-
	Residual Cl2 Combined	0.40	0.40	0.40	0.45	0.45	0.45	0.50	0.50	0.50	0.45	0.40	0.45
	Residual Cl2 Total	-	-	-	-	-	-	-	-	-	-	-	-
AUG	Cl2 Demand	-	-	-	-	-	-	-	-	-	-	-	-
	Cl2 Dosage	-	-	-	-	-	-	-	-	-	-	-	-
	Ammonia	-	-	-	-	-	-	-	-	-	-	-	-
	SO2	-	-	-	-	-	-	-	-	-	-	-	-
	Residual Cl2 Free	-	-	-	-	-	-	-	-	-	-	-	-
	Residual Cl2 Combined	-	-	-	-	-	-	-	-	-	-	-	-
	Residual Cl2 Total	-	-	-	-	-	-	-	-	-	-	-	-

Note: Residual chlorine results were obtained using the DPO method. In this method the accuracy is overstated and is only an approximation of the chlorine residual.

TABLE 3.0: DISINFECTION SUMMARY
SAULT STE. MARIE (STEELTON)

MOE WPOS PROTOCOL

		1986			1985			1984			1983		
		CHLORINATION			CHLORINATION			CHLORINATION			CHLORINATION		
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG
JUN	Cl2 Demand	-	-	-	-	-	-	-	-	-	-	-	-
	Cl2 Dosage	-	-	-	-	-	-	-	-	-	-	-	-
	Ammonia	-	-	-	-	-	-	-	-	-	-	-	-
	SO2	-	-	-	-	-	-	-	-	-	-	-	-
	Residual Cl2 Free	-	-	-	-	-	-	-	-	-	-	-	-
	Residual Cl2 Combined	-	-	-	-	-	-	-	-	-	-	-	-
	Residual Cl2 Total	-	-	-	-	-	-	-	-	-	-	-	-
JUL	Cl2 Demand	-	-	-	-	-	-	-	-	-	-	-	-
	Cl2 Dosage	0.56	0.34	0.44	0.47	0.29	0.40	0.45	0.28	0.39	0.45	0.28	0.38
	Ammonia	0.25	0.15	0.17	0.23	0.11	0.17	0.22	0.11	0.16	0.17	0.11	0.15
	SO2	-	-	-	-	-	-	-	-	-	-	-	-
	Residual Cl2 Free	-	-	-	-	-	-	-	-	-	-	-	-
	Residual Cl2 Combined	0.40	0.40	0.40	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.40	0.40
	Residual Cl2 Total	-	-	-	-	-	-	-	-	-	-	-	-
AUG	Cl2 Demand	-	-	-	-	-	-	-	-	-	-	-	-
	Cl2 Dosage	-	-	-	-	-	-	-	-	-	-	-	-
	Ammonia	-	-	-	-	-	-	-	-	-	-	-	-
	SO2	-	-	-	-	-	-	-	-	-	-	-	-
	Residual Cl2 Free	-	-	-	-	-	-	-	-	-	-	-	-
	Residual Cl2 Combined	-	-	-	-	-	-	-	-	-	-	-	-
	Residual Cl2 Total	-	-	-	-	-	-	-	-	-	-	-	-

Note: Residual chlorine results were obtained using the DPD method. In this method the accuracy is overstated and is only an approximation of the chlorine residual.

TABLE 4

WATER PLANT OPTIMIZATION STUDY
"WATER QUALITY SUMMARY"

Table 4.0

No DWSP information was available on the newly constructed water treatment plant at Gros Cap

TABLE 5

WATER PLANT OPTIMIZATION STUDY
"PARTICULATE COUNTING, SUSPENDED SOLIDS AND ALGAE COUNTS"

Table 5.0

No information available.

TABLE 6

WATER PLANT OPTIMIZATION STUDY
"BACTERIOLOGICAL TESTING"

TABLE 6.1: GOULAIS AVE. WELLS
BACTERIOLOGICAL TESTING (1986)

MOE WPOS PROTOCOL

		TOTAL COLIFORM					FECAL COLIFORM				
		Absent	1-5	6-100	101-5000	>5000	Absent	1-5	6-10	11-500	>500
JAN	R	22	0	0	0	0	22	0	0	0	0
	T	22	0	0	0	0	22	0	0	0	0
FEB	R	14	0	0	0	0	14	0	0	0	0
	T	15	0	0	0	0	15	0	0	0	0
MAR	R	19	0	0	0	0	19	0	0	0	0
	T	18	0	0	0	0	18	0	0	0	0
APR	R	11	0	0	0	0	11	0	0	0	0
	T	22	0	0	0	0	22	0	0	0	0
MAY	R	15	0	0	0	0	15	0	0	0	0
	T	21	0	0	0	0	21	0	0	0	0
JUN	R	12	0	0	0	0	12	0	0	0	0
	T	21	0	0	0	0	21	0	0	0	0
JUL	R	17	0	0	0	0	17	0	0	0	0
	T	22	0	0	0	0	22	0	0	0	0
AUG	R	7	0	0	0	0	7	0	0	0	0
	T	20	0	0	0	0	20	0	0	0	0
SEP	R	8	0	0	0	0	8	0	0	0	0
	T	21	0	0	0	0	21	0	0	0	0
OCT	R	22	0	0	0	0	22	0	0	0	0
	T	22	0	0	0	0	22	0	0	0	0
NOV	R	14	0	0	0	0	14	0	0	0	0
	T	20	0	0	0	0	20	0	0	0	0
DEC	R	–	–	–	–	–	–	–	–	–	–
	T	–	–	–	–	–	–	–	–	–	–

NOTE: All results are for 100 mL samples.
R = Raw Water.
T = Treated Water.

TABLE 6.1: LORNA WELLS
BACTERIOLOGICAL TESTING (1986)

MOE WPOS PROTOCOL

		TOTAL COLIFORM					FECAL COLIFORM				
		Absent	1-5	6-100	101-5000	>5000	Absent	1-5	6-10	11-500	>500
JAN	R1	18	0	0	0	0	18	0	0	0	0
	R2	18	0	0	0	0	18	0	0	0	0
	T	20	0	0	0	0	20	0	0	0	0
FEB	R1	8	0	0	0	0	8	0	0	0	0
	R2	20	0	0	0	0	20	0	0	0	0
	T	21	0	0	0	0	21	0	0	0	0
MAR	R1	13	0	0	0	0	13	0	0	0	0
	R2	14	0	0	0	0	14	0	0	0	0
	T	19	0	0	0	0	19	0	0	0	0
APR	R1	8	0	0	0	0	8	0	0	0	0
	R2	8	0	0	0	0	8	0	0	0	0
	T	22	0	0	0	0	22	0	0	0	0
MAY	R1	19	0	0	0	0	19	0	0	0	0
	R2	17	0	0	0	0	17	0	0	0	0
	T	21	0	0	0	0	21	0	0	0	0
JUN	R1	7	0	0	0	0	7	0	0	0	0
	R2	9	0	0	0	0	9	0	0	0	0
	T	22	0	0	0	0	22	0	0	0	0
JUL	R1	15	0	0	0	0	15	0	0	0	0
	R2	18	0	0	0	0	18	0	0	0	0
	T	22	0	0	0	0	22	0	0	0	0
AUG	R1	6	0	0	0	0	6	0	0	0	0
	R2	16	0	0	0	0	16	0	0	0	0
	T	20	0	0	0	0	20	0	0	0	0
SEP	R1	3	0	0	0	0	3	0	0	0	0
	R2	6	0	0	0	0	6	0	0	0	0
	T	21	0	0	0	0	21	0	0	0	0
OCT	R1	4	0	0	0	0	4	0	0	0	0
	R2	7	0	0	0	0	7	0	0	0	0
	T	22	0	0	0	0	22	0	0	0	0
NOV	R1	3	0	0	0	0	3	0	0	0	0
	R2	5	0	0	0	0	5	0	0	0	0
	T	19	0	0	0	0	19	0	0	0	0
DEC	R1	–	–	–	–	–	–	–	–	–	–
	R2	–	–	–	–	–	–	–	–	–	–
	T	–	–	–	–	–	–	–	–	–	–

NOTE: All results are for 100 mL samples.
R1 = Raw Water – Well #1.
R2 = Raw Water – Well #2.
T = Treated Water.

TABLE 6.1: SHANNON RD. PUMPING STATION
BACTERIOLOGICAL TESTING (1986)

MOE WPOS PROTOCOL

		TOTAL COLIFORM					FECAL COLIFORM				
		Absent	1-5	6-100	101-5000	>5000	Absent	1-5	6-10	11-500	>500
JAN	R	21	0	0	0	0	21	0	0	0	0
	T	21	0	0	0	0	21	0	0	0	0
FEB	R	14	0	0	0	0	14	0	0	0	0
	T	19	0	0	0	0	19	0	0	0	0
MAR	R	16	0	0	0	0	16	0	0	0	0
	T	19	0	0	0	0	19	0	0	0	0
APR	R	14	0	0	0	0	14	0	0	0	0
	T	22	0	0	0	0	22	0	0	0	0
MAY	R	11	0	0	0	0	11	0	0	0	0
	T	21	0	0	0	0	21	0	0	0	0
JUN	R	14	0	0	0	0	14	0	0	0	0
	T	21	0	0	0	0	21	0	0	0	0
JUL	R	7	0	0	0	0	7	0	0	0	0
	T	22	0	0	0	0	22	0	0	0	0
AUG	R	13	0	0	0	0	13	0	0	0	0
	T	20	0	0	0	0	20	0	0	0	0
SEP	R	3	0	0	0	0	3	0	0	0	0
	T	20	0	0	0	0	20	0	0	0	0
OCT	R	7	0	0	0	0	7	0	0	0	0
	T	22	0	0	0	0	22	0	0	0	0
NOV	R	6	0	0	0	0	6	0	0	0	0
	T	19	0	0	0	0	19	0	0	0	0
DEC	R	–	–	–	–	–	–	–	–	–	–
	T	–	–	–	–	–	–	–	–	–	–

NOTE: All results are for 100 mL samples.
R = Raw Water.
T = Treated Water.

TABLE 6.1: STEELTON PUMPING STATION
BACTERIOLOGICAL TESTING (1986)

MOE WPOS PROTOCOL

		TOTAL COLIFORM					FECAL COLIFORM				
		Absent	1-5	6-100	101-5000	>5000	Absent	1-5	6-10	11-500	>500
JAN	R	1	0	0	0	0	1	0	0	0	0
	T	2	0	0	0	0	2	0	0	0	0
FEB	R	20	0	0	0	0	20	0	0	0	0
	T	20	0	0	0	0	20	0	0	0	0
MAR	R	19	0	0	0	0	19	0	0	0	0
	T	19	0	0	0	0	19	0	0	0	0
APR	R	22	0	0	0	0	22	0	0	0	0
	T	22	0	0	0	0	22	0	0	0	0
MAY	R	20	0	0	0	0	20	0	0	0	0
	T	21	0	0	0	0	21	0	0	0	0
JUN	R	19	0	3	0	0	22	0	0	0	0
	T	21	0	0	0	0	21	0	0	0	0
JUL	R	22	0	0	0	0	22	0	0	0	0
	T	22	0	0	0	0	22	0	0	0	0
AUG	R	20	0	0	0	0	20	0	0	0	0
	T	20	0	0	0	0	20	0	0	0	0
SEP	R	14	1	0	0	0	15	0	0	0	0
	T	21	0	0	0	0	21	0	0	0	0
OCT	R	8	0	0	0	0	8	0	0	0	0
	T	8	0	0	0	0	8	0	0	0	0
NOV	R	6	0	0	0	0	6	0	0	0	0
	T	7	0	0	0	0	7	0	0	0	0
DEC	R	–	–	–	–	–	–	–	–	–	–
	T	–	–	–	–	–	–	–	–	–	–

NOTE: All results are for 100 mL samples.
R = Raw Water.
T = Treated Water.

TABLE 6.1: GOULAIS AVE. WELLS
BACTERIOLOGICAL TESTING (1984)

MOE WPOS PROTOCOL

		TOTAL COLIFORM					FECAL COLIFORM				
		Absent	1-5	6-100	101-5000	>5000	Absent	1-5	6-10	11-500	>500
JAN	R	21	0	0	0	0	21	0	0	0	0
	T	21	0	0	0	0	21	0	0	0	0
FEB	R	21	0	0	0	0	21	0	0	0	0
	T	21	0	0	0	0	21	0	0	0	0
MAR	R	16	4	2	0	0	21	1	0	0	0
	T	21	0	0	0	0	22	0	0	0	0
APR	R	45	0	0	0	0	45	0	0	0	0
	T	18	0	0	0	0	18	0	0	0	0
MAY	R	22	0	0	0	0	22	0	0	0	0
	T	22	0	0	0	0	22	0	0	0	0
JUN	R	21	0	0	0	0	21	0	0	0	0
	T	21	0	0	0	0	21	0	0	0	0
JUL	R	21	0	0	0	0	21	0	0	0	0
	T	21	0	0	0	0	21	0	0	0	0
AUG	R	22	0	0	0	0	22	0	0	0	0
	T	22	0	0	0	0	22	0	0	0	0
SEP	R	17	1	0	0	0	18	0	0	0	0
	T	19	0	0	0	0	19	0	0	0	0
OCT	R	22	0	0	0	0	22	0	0	0	0
	T	22	0	0	0	0	22	0	0	0	0
NOV	R	20	1	0	0	0	20	1	0	0	0
	T	21	0	0	0	0	21	0	0	0	0
DEC	R	19	0	0	0	0	19	0	0	0	0
	T	19	0	0	0	0	19	0	0	0	0

NOTE: All results are for 100 mL samples.
R = Raw Water.
T = Treated Water.

TABLE 6.1: LORNA WELLS
BACTERIOLOGICAL TESTING (1984)

MOE WPOS PROTOCOL

		TOTAL COLIFORM					FECAL COLIFORM				
		Absent	1-5	6-100	101-5000	>5000	Absent	1-5	6-10	11-500	>500
JAN	R	21	0	0	0	0	21	0	0	0	0
	T	21	0	0	0	0	21	0	0	0	0
FEB	R	21	0	0	0	0	21	0	0	0	0
	T	21	0	0	0	0	21	0	0	0	0
MAR	R	20	0	0	0	0	20	0	0	0	0
	T	22	0	0	0	0	22	0	0	0	0
APR	R	19	0	0	0	0	19	0	0	0	0
	T	19	0	0	0	0	19	0	0	0	0
MAY	R	22	0	0	0	0	22	0	0	0	0
	T	22	0	0	0	0	22	0	0	0	0
JUN	R	21	0	0	0	0	21	0	0	0	0
	T	21	0	0	0	0	21	0	0	0	0
JUL	R	22	0	0	0	0	22	0	0	0	0
	T	22	0	0	0	0	22	0	0	0	0
AUG	R	18	0	0	0	0	18	0	0	0	0
	T	22	0	0	0	0	22	0	0	0	0
SEP	R	18	0	0	0	0	18	0	0	0	0
	T	19	0	0	0	0	19	0	0	0	0
OCT	R	22	0	0	0	0	22	0	0	0	0
	T	22	0	0	0	0	22	0	0	0	0
NOV	R	21	0	0	0	0	21	0	0	0	0
	T	21	0	0	0	0	21	0	0	0	0
DEC	R	19	0	0	0	0	19	0	0	0	0
	T	19	0	0	0	0	19	0	0	0	0

NOTE: All results are for 100 mL samples.
R = Raw Water.
T = Treated Water.

TABLE 6.1: SHANNON RD. PUMPING STATION
BACTERIOLOGICAL TESTING (1984)

MOE WPOS PROTOCOL

		TOTAL COLIFORM					FECAL COLIFORM				
		Absent	1-5	6-100	101-5000	>5000	Absent	1-5	6-10	11-500	>500
JAN	R	21	0	0	0	0	21	0	0	0	0
	T	21	0	0	0	0	21	0	0	0	0
FEB	R	21	0	0	0	0	21	0	0	0	0
	T	21	0	0	0	0	21	0	0	0	0
MAR	R	22	0	0	0	0	22	0	0	0	0
	T	18	0	0	0	0	18	0	0	0	0
APR	R	19	0	0	0	0	19	0	0	0	0
	T	19	0	0	0	0	19	0	0	0	0
MAY	R	22	0	0	0	0	22	0	0	0	0
	T	22	0	0	0	0	22	0	0	0	0
JUN	R	21	0	0	0	0	21	0	0	0	0
	T	21	0	0	0	0	21	0	0	0	0
JUL	R	23	0	0	0	0	23	0	0	0	0
	T	22	0	0	0	0	22	0	0	0	0
AUG	R	22	0	0	0	0	22	0	0	0	0
	T	23	0	0	0	0	23	0	0	0	0
SEP	R	16	0	0	0	0	16	0	0	0	0
	T	19	0	0	0	0	19	0	0	0	0
OCT	R	22	0	0	0	0	22	0	0	0	0
	T	22	0	0	0	0	22	0	0	0	0
NOV	R	19	0	0	0	0	19	0	0	0	0
	T	21	0	0	0	0	21	0	0	0	0
DEC	R	18	0	0	0	0	18	0	0	0	0
	T	19	0	0	0	0	19	0	0	0	0

NOTE: All results are for 100 mL samples.
R = Raw Water.
T = Treated Water.

TABLE 6.1: STEELTON PUMPING STATION
BACTERIOLOGICAL TESTING (1984)

MOE WPOS PROTOCOL

		TOTAL COLIFORM					FECAL COLIFORM				
		Absent	1-5	6-100	101-5000	>5000	Absent	1-5	6-10	11-500	>500
JAN	R	21	0	0	0	0	21	0	0	0	0
	T	21	0	0	0	0	21	0	0	0	0
FEB	R	21	0	0	0	0	21	0	0	0	0
	T	21	0	0	0	0	21	0	0	0	0
MAR	R	21	0	0	0	0	21	0	0	0	0
	T	21	0	0	0	0	21	0	0	0	0
APR	R	19	0	0	0	0	19	0	0	0	0
	T	19	0	0	0	0	19	0	0	0	0
MAY	R	21	0	0	0	0	21	0	0	0	0
	T	21	0	0	0	0	21	0	0	0	0
JUN	R	24	0	0	0	0	24	0	0	0	0
	T	24	0	0	0	0	24	0	0	0	0
JUL	R	21	0	0	0	0	21	0	0	0	0
	T	21	0	0	0	0	21	0	0	0	0
AUG	R	22	0	0	0	0	22	0	0	0	0
	T	22	0	0	0	0	22	0	0	0	0
SEP	R	18	1	0	0	0	19	0	0	0	0
	T	19	0	0	0	0	19	0	0	0	0
OCT	R	22	0	0	0	0	22	0	0	0	0
	T	22	0	0	0	0	22	0	0	0	0
NOV	R	21	0	0	0	0	21	0	0	0	0
	T	21	0	0	0	0	21	0	0	0	0
DEC	R	19	0	0	0	0	19	0	0	0	0
	T	19	0	0	0	0	19	0	0	0	0

NOTE: All results are for 100 mL samples.
R = Raw Water.
T = Treated Water.

TABLE 6.2: SAULT STE MARIE WATER TREATMENT PLANT
BACTERIOLOGICAL TESTING (1986)

MOE WPOS PROTOCOL

		TOTAL COLIFORM					FECAL COLIFORM				
		Absent	1-5	6-100	101-5000	>5000	Absent	1-5	6-10	11-500	>500
JAN	R	–	–	–	–	–	–	–	–	–	–
	T	–	–	–	–	–	–	–	–	–	–
FEB	R	–	–	–	–	–	–	–	–	–	–
	T	–	–	–	–	–	–	–	–	–	–
MAR	R	–	–	–	–	–	–	–	–	–	–
	T	–	–	–	–	–	–	–	–	–	–
APR	R	–	–	–	–	–	–	–	–	–	–
	T	–	–	–	–	–	–	–	–	–	–
MAY	R	–	–	–	–	–	–	–	–	–	–
	T	–	–	–	–	–	–	–	–	–	–
JUN	R	91	0	0	0	0	91	0	0	0	0
	T	364	0	0	0	0	364	0	0	0	0
JUL	R	93	0	0	0	0	93	0	0	0	0
	T	382	0	0	0	0	382	0	0	0	0
AUG	R	18	4	0	0	0	22	0	0	0	0
	T	368	0	0	0	0	368	0	0	0	0
SEP	R	7	10	4	0	0	19	2	0	0	0
	T	256	0	0	0	0	256	0	0	0	0
OCT	R	65	28	1	0	0	89	5	0	0	0
	T	188	0	0	0	0	188	0	0	0	0
NOV	R	59	22	9	0	0	84	6	0	0	0
	T	182	0	0	0	0	182	0	0	0	0
DEC	R	64	23	3	0	0	83	7	0	0	0
	T	180	0	0	0	0	180	0	0	0	0

NOTE: All results are for 100 mL samples.
R = Raw Water.
T = Treated Water.

TABLE 6.2: SAULT STE MARIE WATER TREATMENT PLANT
BACTERIOLOGICAL TESTING (1987)

MOE WPOS PROTOCOL

		TOTAL COLIFORM					FECAL COLIFORM				
		Absent	1-5	6-100	101-5000	>5000	Absent	1-5	6-10	11-500	>500
JAN	R	87	6	0	0	0	91	2	0	0	0
	T	186	0	0	0	0	186	0	0	0	0
FEB	R	82	2	1	0	0	85	0	0	0	0
	T	172	0	0	0	0	172	0	0	0	0
MAR	R	90	3	0	0	0	92	1	0	0	0
	T	185	0	0	0	0	185	0	0	0	0
APR	R	76	12	1	0	0	80	10	0	0	0
	T	180	0	0	0	0	180	0	0	0	0
MAY	R	95	3	0	0	0	96	2	0	0	0
	T	178	0	0	0	0	178	0	0	0	0
JUN	R	77	13	0	0	0	86	4	0	0	0
	T	180	0	0	0	0	180	0	0	0	0
JUL	R	30	27	25	0	0	70	21	0	0	0
	T	176	0	0	0	0	176	0	0	0	0
AUG	R	25	51	17	0	0	68	25	0	0	0
	T	178	0	0	0	0	178	0	0	0	0
SEP	R	19	41	30	0	0	85	5	0	0	0
	T	178	0	0	0	0	178	0	0	0	0
OCT	R	20	40	33	0	0	86	7	0	0	0
	T	186	0	0	0	0	186	0	0	0	0
NOV	R	49	35	6	0	0	82	8	0	0	0
	T	180	0	0	0	0	180	0	0	0	0
DEC	R	55	31	0	0	0	68	18	0	0	0
	T	178	0	0	0	0	178	0	0	0	0

NOTE: All results are for 100 mL samples.
R = Raw Water.
T = Treated Water.

TABLE 6.2: SAULT STE MARIE WATER TREATMENT PLANT
BACTERIOLOGICAL TESTING (1988)

MOE WPOS PROTOCOL

		TOTAL COLIFORM					FECAL COLIFORM				
		Absent	1-5	6-100	101-5000	>5000	Absent	1-5	6-10	11-500	>500
JAN	R	90	3	0	0	0	92	1	0	0	0
	T	186	0	0	0	0	186	0	0	0	0
FEB	R	87	0	0	0	0	87	0	0	0	0
	T	174	0	0	0	0	174	0	0	0	0
MAR	R	91	5	0	0	0	95	1	0	0	0
	T	192	0	0	0	0	192	0	0	0	0
APR	R	67	21	2	0	0	73	17	0	0	0
	T	180	0	0	0	0	180	0	0	0	0
MAY	R	75	18	0	0	0	88	5	0	0	0
	T	186	0	0	0	0	186	0	0	0	0
JUN	R	70	19	1	0	0	85	5	0	0	0
	T	180	0	0	0	0	180	0	0	0	0
JUL	R	54	37	2	0	0	83	10	0	0	0
	T	186	0	0	0	0	186	0	0	0	0
AUG	R	18	38	32	2	0	70	20	0	0	0
	T	183	1	0	0	0	184	0	0	0	0
SEP	R	25	51	13	1	0	83	7	0	0	0
	T	180	0	0	0	0	180	0	0	0	0
OCT	R	31	44	18	0	0	86	7	0	0	0
	T	186	0	0	0	0	186	0	0	0	0
NOV	R	55	33	1	0	0	84	5	0	0	0
	T	179	0	0	0	0	179	0	0	0	0
DEC	R	65	16	0	0	0	77	4	0	0	0
	T	179	1	0	0	0	179	1	0	0	0

NOTE: All results are for 100 mL samples.
R = Raw Water.
T = Treated Water.

TABLE 6.2: SAULT STE MARIE WATER TREATMENT PLANT
BACTERIOLOGICAL TESTING (1989)

MOE WPOS PROTOCOL

		TOTAL COLIFORM					FECAL COLIFORM				
		Absent	1-5	6-100	101-5000	>5000	Absent	1-5	6-10	11-500	>500
JAN	R	96	0	0	0	0	96	0	0	0	0
	T	191	0	0	0	0	191	0	0	0	0
FEB	R	84	0	0	0	0	84	0	0	0	0
	T	168	0	0	0	0	168	0	0	0	0
MAR	R	92	1	0	0	0	93	0	0	0	0
	T	186	0	0	0	0	186	0	0	0	0
APR	R	79	11	0	0	0	86	4	0	0	0
	T	180	0	0	0	0	180	0	0	0	0
MAY	R	87	5	0	0	0	91	2	0	0	0
	T	196	0	0	0	0	196	0	0	0	0
JUN	R	84	3	1	0	0	87	1	0	0	0
	T	180	1	0	0	0	180	1	0	0	0
JUL	R	56	22	14	0	0	88	4	0	0	0
	T	182	1	0	0	0	183	0	0	0	0
AUG	R	44	33	15	0	0	80	12	0	0	0
	T	185	0	0	0	0	185	0	0	0	0
SEP	R	33	43	14	0	0	71	19	0	0	0
	T	180	0	0	0	0	180	0	0	0	0
OCT	R	53	27	6	0	0	85	1	0	0	0
	T	172	0	0	0	0	172	0	0	0	0
NOV	R	67	20	2	0	0	86	3	0	0	0
	T	178	0	0	0	0	178	0	0	0	0
DEC	R	77	13	0	0	0	89	1	0	0	0
	T	180	0	0	0	0	180	0	0	0	0

NOTE: All results are for 100 mL samples.
R = Raw Water.
T = Treated Water.

TABLE 6.2: SAULT STE MARIE WATER TREATMENT PLANT BACTERIOLOGICAL TESTING (1990)

MOE WPOS PROTOCOL

		TOTAL COLIFORM					FECAL COLIFORM				
		Absent	1-5	6-100	101-5000	>5000	Absent	1-5	6-10	11-500	>500
JAN	R	92	4	0	0	0	96	0	0	0	0
	T	192	0	0	0	0	192	0	0	0	0
FEB	R	84	0	0	0	0	84	0	0	0	0
	T	168	0	0	0	0	168	0	0	0	0
MAR	R	86	4	0	0	0	86	4	0	0	0
	T	180	0	0	0	0	180	0	0	0	0
APR	R	89	4	0	0	0	90	0	0	0	0
	T	185	1	0	0	0	186	0	0	0	0
MAY	R	83	6	0	0	0	89	0	0	0	0
	T	178	0	0	0	0	178	0	0	0	0
JUN	R	73	16	0	0	0	89	0	0	0	0
	T	178	0	0	0	0	178	0	0	0	0
JUL	R	51	40	2	0	0	88	5	0	0	0
	T	186	0	0	0	0	186	0	0	0	0
AUG	R	40	51	0	0	0	84	9	0	0	0
	T	186	0	0	0	0	186	0	0	0	0
SEP	R	34	51	5	0	0	84	6	0	0	0
	T	180	0	0	0	0	180	0	0	0	0
OCT	R	45	45	2	0	0	84	8	0	0	0
	T	187	0	0	0	0	187	0	0	0	0
NOV	R	65	25	0	0	0	87	3	0	0	0
	T	180	0	0	0	0	180	0	0	0	0
DEC	R	–	–	–	–	–	–	–	–	–	–
	T	–	–	–	–	–	–	–	–	–	–

NOTE: All results are for 100 mL samples.
R = Raw Water.
T = Treated Water.

TABLE 6.3: SAULT STE MARIE SECOND LINE RESERVOIR BACTERIOLOGICAL TESTING (1984)

MOE WPOS PROTOCOL

		TOTAL COLIFORM					FECAL COLIFORM				
		Absent	1-5	6-100	101-5000	>5000	Absent	1-5	6-10	11-500	>500
JAN	R	–	–	–	–	–	–	–	–	–	–
	T	21	0	0	0	0	21	0	0	0	0
FEB	R	–	–	–	–	–	–	–	–	–	–
	T	21	0	0	0	0	21	0	0	0	0
MAR	R	–	–	–	–	–	–	–	–	–	–
	T	22	0	0	0	0	22	0	0	0	0
APR	R	–	–	–	–	–	–	–	–	–	–
	T	19	0	0	0	0	19	0	0	0	0
MAY	R	–	–	–	–	–	–	–	–	–	–
	T	22	0	0	0	0	22	0	0	0	0
JUN	R	–	–	–	–	–	–	–	–	–	–
	T	21	0	0	0	0	21	0	0	0	0
JUL	R	–	–	–	–	–	–	–	–	–	–
	T	21	0	0	0	0	21	0	0	0	0
AUG	R	–	–	–	–	–	–	–	–	–	–
	T	22	0	0	0	0	22	0	0	0	0
SEP	R	–	–	–	–	–	–	–	–	–	–
	T	17	1	0	0	0	18	0	0	0	0
OCT	R	–	–	–	–	–	–	–	–	–	–
	T	22	0	0	0	0	22	0	0	0	0
NOV	R	–	–	–	–	–	–	–	–	–	–
	T	20	0	0	0	0	20	0	0	0	0
DEC	R	–	–	–	–	–	–	–	–	–	–
	T	19	0	0	0	0	19	0	0	0	0

NOTE: All results are for 100 mL samples.
R = Raw Water.
T = Treated Water.

TABLE 6.3: SECOND LINE RESERVOIR
BACTERIOLOGICAL TESTING (1986)

MOE WPOS PROTOCOL

		TOTAL COLIFORM					FECAL COLIFORM				
		Absent	1-5	6-100	101-5000	>5000	Absent	1-5	6-10	11-500	>500
JAN	R	–	–	–	–	–	–	–	–	–	–
	T	22	0	0	0	0	22	0	0	0	0
FEB	R	–	–	–	–	–	–	–	–	–	–
	T	12	0	0	0	0	12	0	0	0	0
MAR	R	–	–	–	–	–	–	–	–	–	–
	T	19	0	0	0	0	19	0	0	0	0
APR	R	–	–	–	–	–	–	–	–	–	–
	T	21	0	0	0	0	21	0	0	0	0
MAY	R	–	–	–	–	–	–	–	–	–	–
	T	21	0	0	0	0	21	0	0	0	0
JUN	R	–	–	–	–	–	–	–	–	–	–
	T	19	0	0	0	0	19	0	0	0	0
JUL	R	–	–	–	–	–	–	–	–	–	–
	T	22	0	0	0	0	22	0	0	0	0
AUG	R	–	–	–	–	–	–	–	–	–	–
	T	19	0	0	0	0	19	0	0	0	0
SEP	R	–	–	–	–	–	–	–	–	–	–
	T	21	0	0	0	0	21	0	0	0	0
OCT	R	–	–	–	–	–	–	–	–	–	–
	T	22	0	0	0	0	22	0	0	0	0
NOV	R	–	–	–	–	–	–	–	–	–	–
	T	20	0	0	0	0	20	0	0	0	0
DEC	R	–	–	–	–	–	–	–	–	–	–
	T	–	–	–	–	–	–	–	–	–	–

NOTE: All results are for 100 mL samples.
R = Raw Water.
T = Treated Water.

TABLE 6.3: SAULT STE MARIE DISTRIBUTION SYSTEM BACTERIOLOGICAL TESTING (1990)

MOE WPOS PROTOCOL

		TOTAL COLIFORM					FECAL COLIFORM				
		Absent	1-5	6-100	101-5000	>5000	Absent	1-5	6-10	11-500	>500
JAN	R	–	–	–	–	–	–	–	–	–	–
	T	–	–	–	–	–	–	–	–	–	–
FEB	R	–	–	–	–	–	–	–	–	–	–
	T	21	0	0	0	0	21	0	0	0	0
MAR	R	–	–	–	–	–	–	–	–	–	–
	T	67	0	0	0	0	67	0	0	0	0
APR	R	–	–	–	–	–	–	–	–	–	–
	T	65	0	0	0	0	65	0	0	0	0
MAY	R	–	–	–	–	–	–	–	–	–	–
	T	75	0	0	0	0	75	0	0	0	0
JUN	R	–	–	–	–	–	–	–	–	–	–
	T	75	0	0	0	0	75	0	0	0	0
JUL	R	–	–	–	–	–	–	–	–	–	–
	T	77	0	0	0	0	77	0	0	0	0
AUG	R	–	–	–	–	–	–	–	–	–	–
	T	76	1	0	0	0	77	0	0	0	0
SEP	R	–	–	–	–	–	–	–	–	–	–
	T	68	0	0	0	0	68	0	0	0	0
OCT	R	–	–	–	–	–	–	–	–	–	–
	T	65	0	0	0	0	65	0	0	0	0
NOV	R	–	–	–	–	–	–	–	–	–	–
	T	–	–	–	–	–	–	–	–	–	–
DEC	R	–	–	–	–	–	–	–	–	–	–
	T	–	–	–	–	–	–	–	–	–	–

NOTE: All results are for 100 mL samples.
R = Raw Water.
T = Treated Water.

TABLE 7

WATER PLANT OPTIMIZATION STUDY
ONTARIO DRINKING WATER OBJECTIVES
EXCEEDANCE SUMMARY

TABLE 7.0: ONTARIO DRINKING WATER OBJECTIVES
INCLUDING ALUMINUM (TREATED WATER AT PLANT)

DATE	PARAMETER	MEASURED PARAMETER	OBJECTIVE LIMIT

* No data avaiable to complete table

TABLE 7.1: ONTARIO DRINKING WATER OBJECTIVES
(DISTRIBUTION SYSTEM)

DATE	PARAMETER	MEASURED PARAMETER	OBJECTIVE LIMIT

* No data avaiable to complete table

APPENDIX B

DAILY LOG SHEETS

SAULT STE. MARIE PUBLIC UTILITIES COMMISSION 86/10/19

DAILY REPORT PAGE 1

CHEMICALS	WEIGHT 00:01 (KG)	WEIGHT 23:59 (KG)	NET CHANGE (KG)	DOSAGE (MG/L)
CHLORINE	2194	2167	29	0
AQUA AMMONIA	356	332	28	0
SULPHUR DIOXIDE	290	288	3	0

WATER QUALITY	AVERAGE	HIGH	LOW
TURBIDITY (NTU)			
GROS CAP	0.6	0.7	0.5
INFLUENT	0.4	0.6	0.4
FILTER 1	0.4	0.8	0.3
FILTER 2	0.4	0.7	0.3
FILTER 3	0.2	0.3	0.2
FILTER 4	0.4	0.5	0.4
OUTPUT	0.0	0.0	0.0
TEMPERATURE (C)			
GROS CAP	10.4	11.5	9.8
PLANT	10.7	11.0	10.5
PLANT PH			
INFLUENT	8.0	8.1	7.9
OUTPUT	7.2	7.4	7.0
CHLORINE RESIDUAL (MG/L)			
CLEARWELL	0.6	0.6	0.5
OUTPUT	0.4	0.7	0.3
SUPERNATANT	0.0*	0.0*	0.0*

POWER CONSUMPTION	READING 00:01 (KW)	READING 23:59 (KW)	KWH
LINE 1	48.8	65.3	2375
LINE 2	34.5	33.8	806

BACKWASH REPORT (2 BACKWASHES COMPLETED)

FILTER 2 BACKWASH		FILTER 1 BACKWASH	
TIME INITIATED	14:27	TIME INITIATED	0: 3
INITIATED MANUALLY		INITIATED BY HEAD LOSS	
ELAPSED TIME	79.0 HOURS	ELAPSED TIME	86.7 HOURS
TEMPERATURE	10.6 DEGC	TEMPERATURE	10.9 DEGC
RISE RATE	65.0 L/S	RISE RATE	65.0 L/S
LOW WASH RATE	175.0 L/S	LOW WASH RATE	175.0 L/S
HIGH WASH RATE	513.7 L/S	HIGH WASH RATE	516.6 L/S
WASHWATER VOLUME	239.7 CU M	WASHWATER VOLUME	251.1 CU M

WATER SYSTEM RECORDS
====================

RESERVOIRS	LEVEL 00:01 (M)	LEVEL 23:59 (M)	NET CHANGE (M)	23:59 VOLUME (CU M)
MARSHALL DVE	10.2	9.6	-1	1513
ZONE 1 RESERVOIR	4.6	3.9	-1	17340
ZONE 2 TANK	11.4	10.9	-1	2664
PLANT RESERVOIR	2.4	2.3	0	-9

PRODUCTION		DAILY TOTAL (CU M)	MONTHLY TOTAL TO DATE (CU M)	MONTHLY AVE DAILY (CU M)	MONTHLY MAX DAILY (CU M)	MONTHLY MIN DAILY (CU M)
GROS CAP						
OUTPUT		18159	442272*	*****	25437	16986
TANK ADJUSTMENT		-110				
NET OUTPUT		18049				
TREATMENT PLANT						
INFLUENT		19379	454372	****	25360	17881
FILTERS		18202	437359	23019		
1	5944		113254		6140	5610
2	6058		114058		6165	5582
3	6200		114261		6203	5753
4	0		95786		6131	0
BACKWASH		580	****	600	923	93
PLANT		240	4463	****	27124	17635
NET PRODUCTION		17383	421487			
PLANT OUTPUT		18138	442563	****	27124	17635
WELLS						
GOULAIS		9177	173017*	9106*	9195	7895
STEELTON		0*	0*	0*	0*	0*
SHANNON		0	40759*	2145*	5877	0
LORNA		6353	72990*	3842*	7626	0
NET OUTPUT		15530	286766			

CONSUMPTION

ZONE 2	
OUTPUT	11488
TANK ADJUSTMENT	-95
NET CONSUMPTION	11393
ZONE 1	
TOTAL PRODUCTION	33668*
RESERVOIR ADJUSTMENT	-3468
LESS ZONE 2	11393
NET CONSUMPTION	25742
TOTAL	37135

WASTEWATER

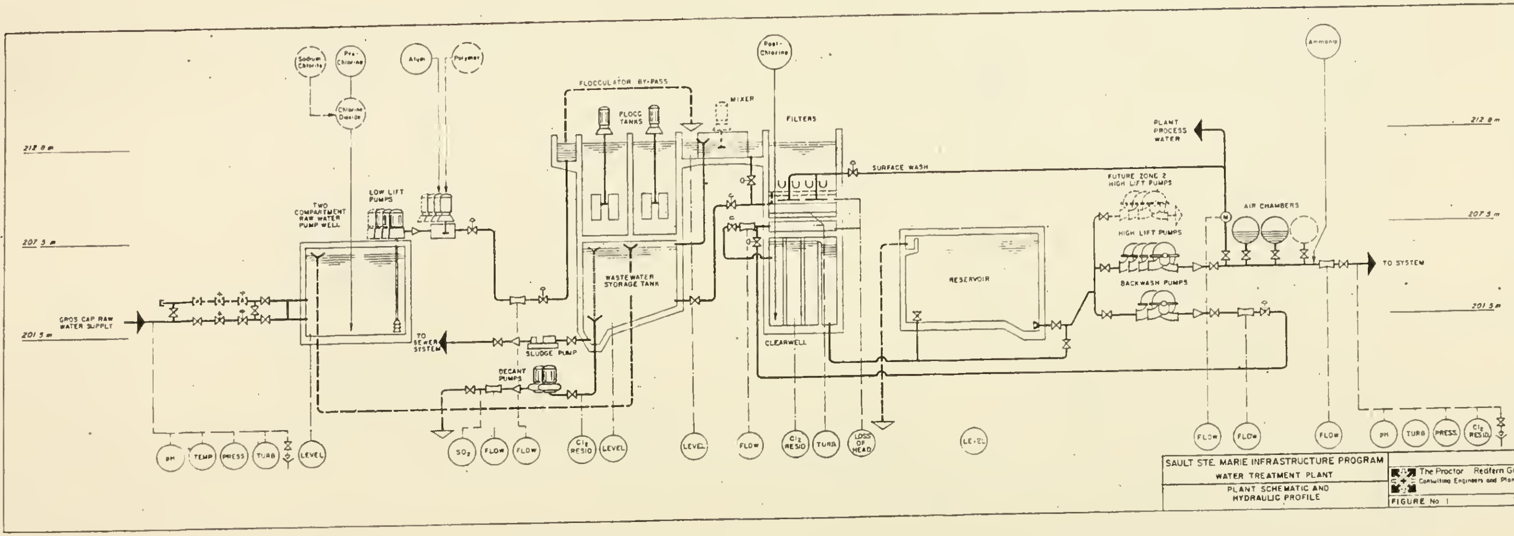
BACKWASH WATER	580
SUPERNATANT	1315
SLUDGE	1300*
% OF INFLUENT FLOW	16

ELECTRICAL SYSTEM

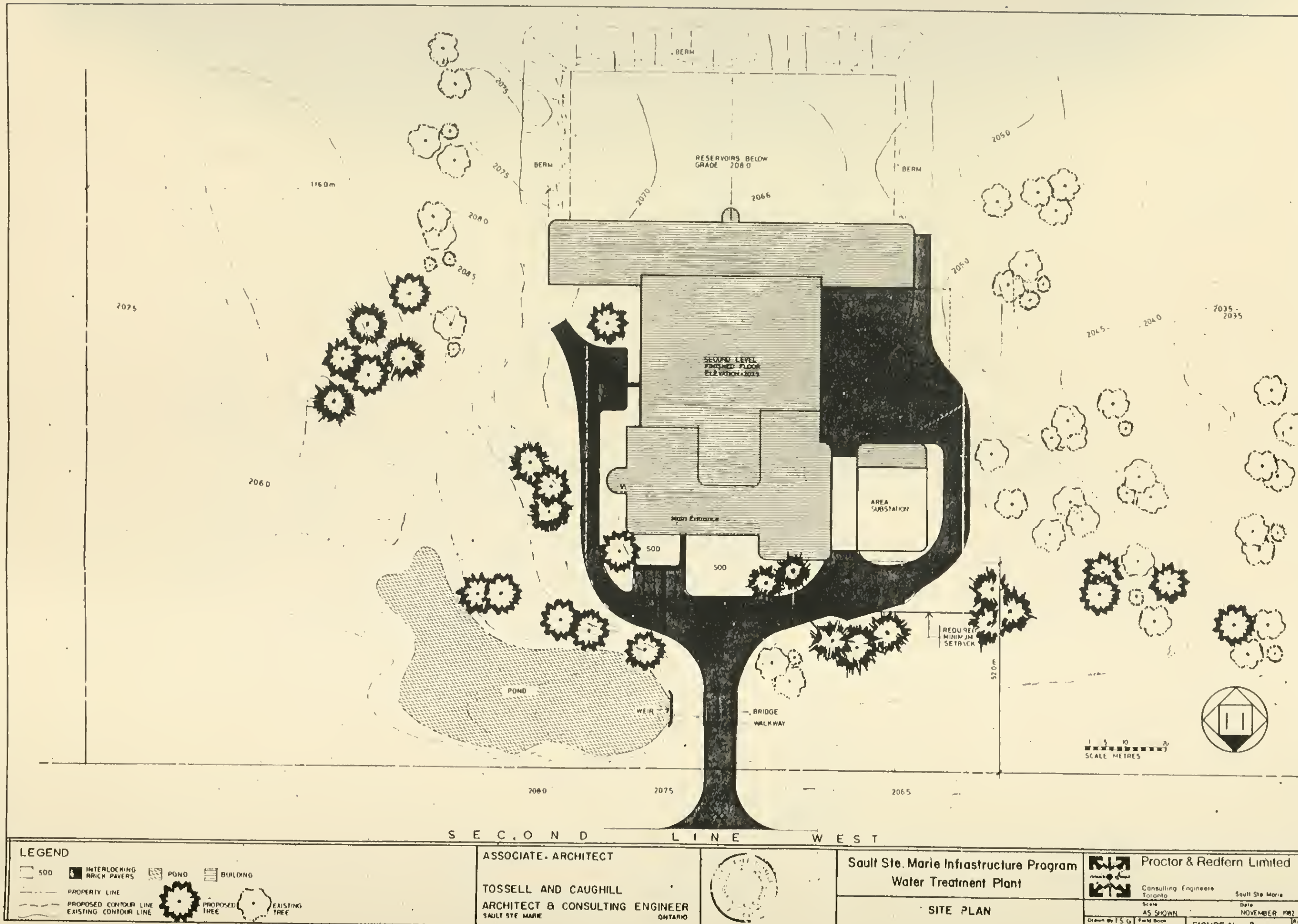
PEAK 80.25 MEGAWATTS

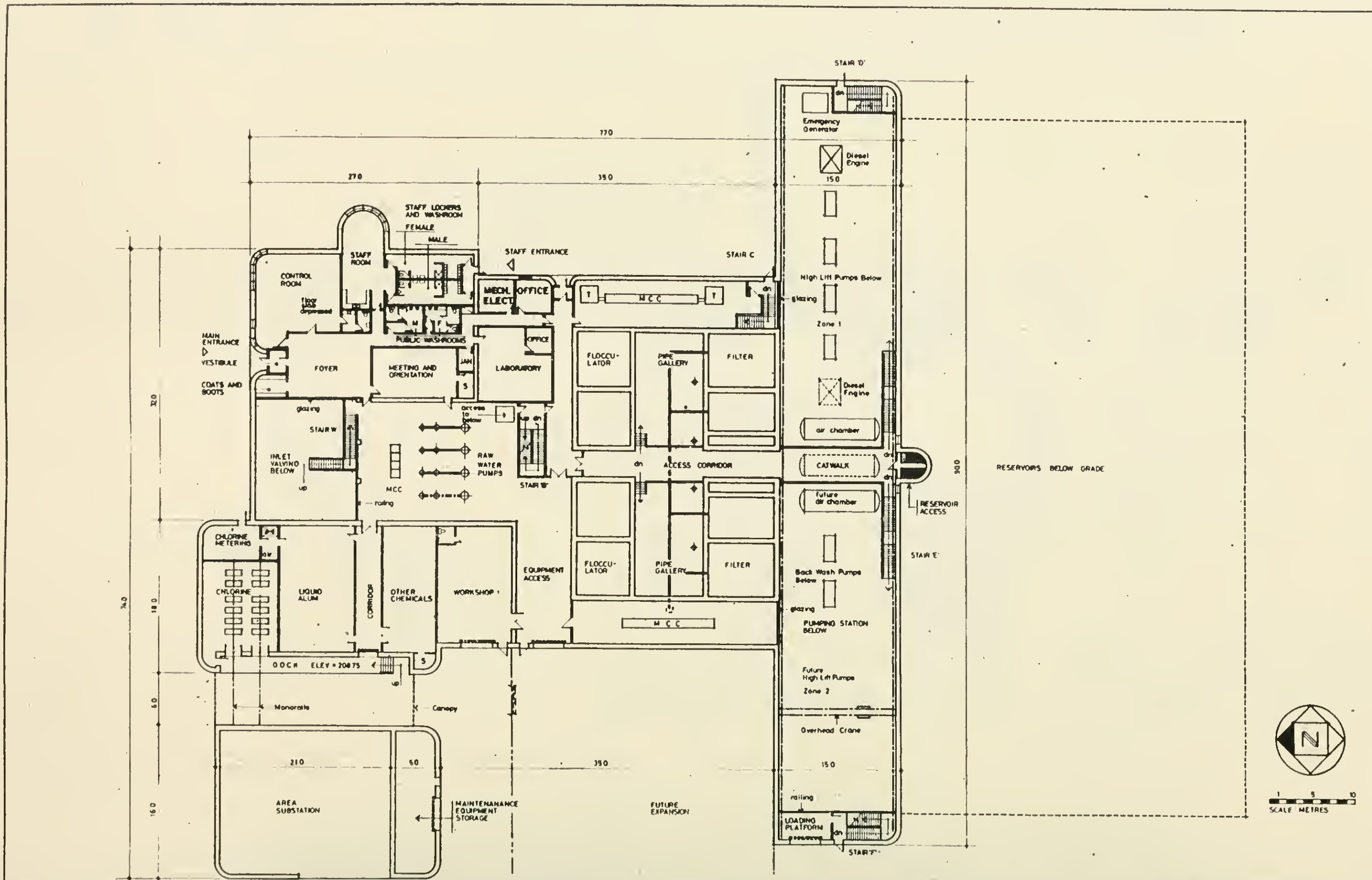
FOR THE HOUR ENDING 1159

APPENDIX C - DRAWINGS



SAULT STE. MARIE INFRASTRUCTURE PROGRAM
WATER TREATMENT PLANT
PLANT SCHEMATIC AND HYDRAULIC PROFILE
FIGURE No. 1


BERM
RESERVOIRS BELOW GRADE 2080
BERM
BERM
2066
2070
2075
2075
2080
2085
1160m
2075
2060
2050
2050
2045
2040
2035 - 2035
SECOND LEVEL FINISHED FLOOR ELEVATION 2075
Main Entrance
500
500
AREA SUBSTATION
REQUIRED MINIMUM SETBACK
520m
POND
WEIR
BRIDGE
WALKWAY
SCALE METRES
2080
2075
2065
SECOND LINE WEST
LEGEND
SOD
INTERLOCKING BRICK PAVERS
POND
BUILDING
PROPERTY LINE
PROPOSED CONTOUR LINE
EXISTING CONTOUR LINE
PROPOSED TREE
EXISTING TREE
ASSOCIATE. ARCHITECT
TOSSELL AND CAUGHILL
ARCHITECT & CONSULTING ENGINEER
SAULT STE MARIE ONTARIO
Sault Ste. Marie Infrastructure Program
Water Treatment Plant
SITE PLAN
Proctor & Redfern Limited
Consulting Engineers Toronto Sault Ste Marie
Scale AS SHOWN
Date NOVEMBER 1982
FIGURE No 2



ASSOCIATE ARCHITECT

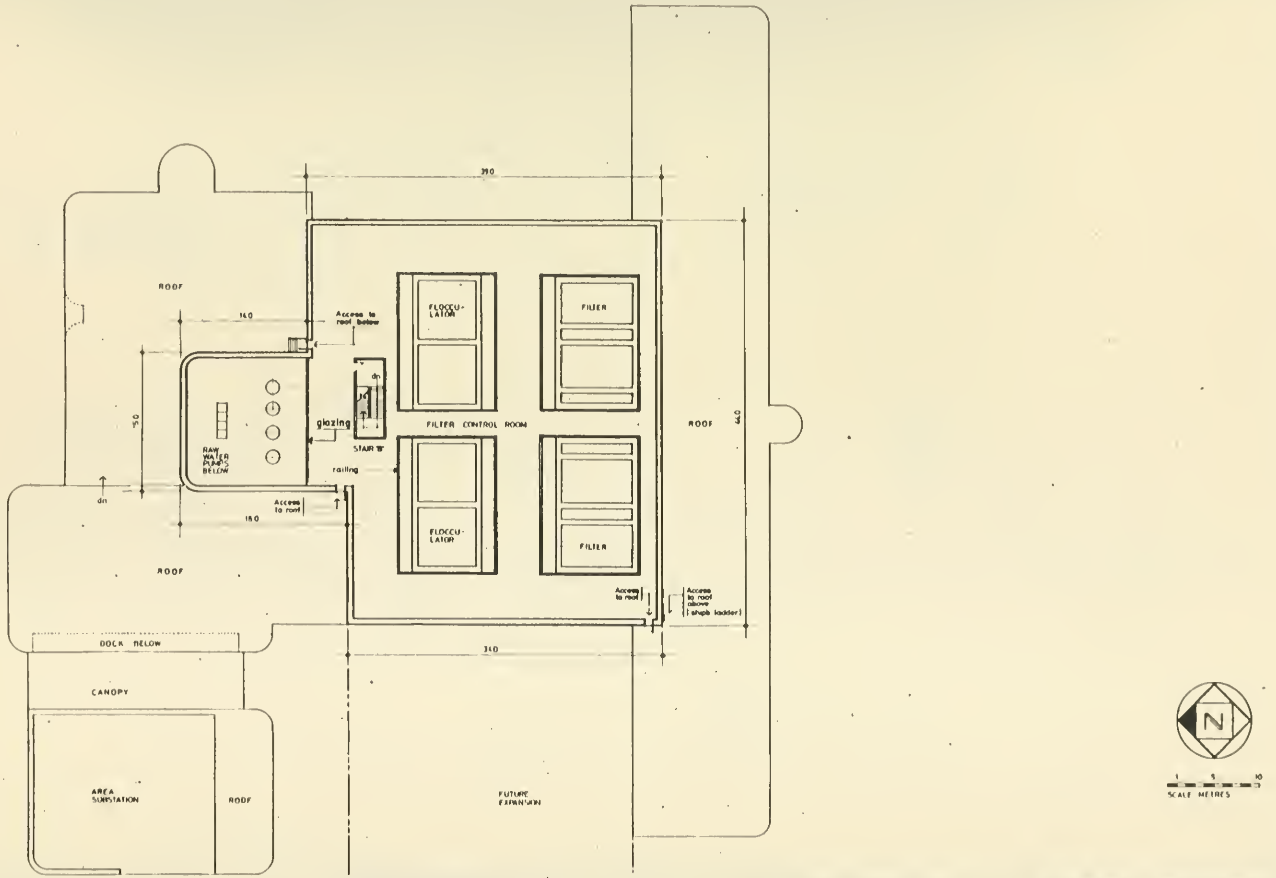
TOSSELL AND CAUGHILL
ARCHITECT & CONSULTING ENGINEER
SAULT STE MARIE ONTARIO

Sault Ste. Marie Infrastructure Program
Water Treatment Plant

MAIN FLOOR PLAN - ELEVATION 207.5

Proctor & Redfern Limited
Consulting Engineers
Toronto Sault Ste Marie

Scale AS SHOWN
Date NOVEMBER 1982
Drawn by TSO
Chd by COT
FIGURE No. 4



ASSOCIATE ARCHITECT

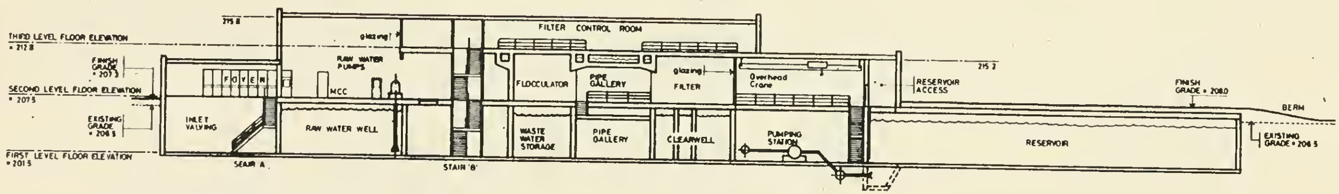
TOSSELL AND CAUGHILL
ARCHITECT & CONSULTING ENGINEER
SAULT STE MARIE ONTARIO

Sault Ste. Marie Infrastructure Program
Water Treatment Plant

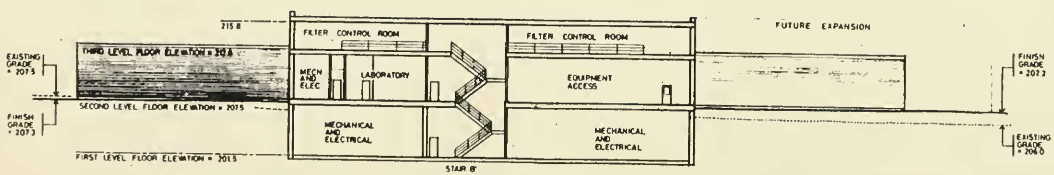
UPPER FLOOR PLAN - ELEVATION 212.8

Proctor & Redfern Limited
Consulting Engineers
Toronto Sault Ste Marie

Scale AS SHOWN
Date NOVEMBER 1982
Drawn by T.S.O.
Chk by C.O.T.
FIGURE No. 5



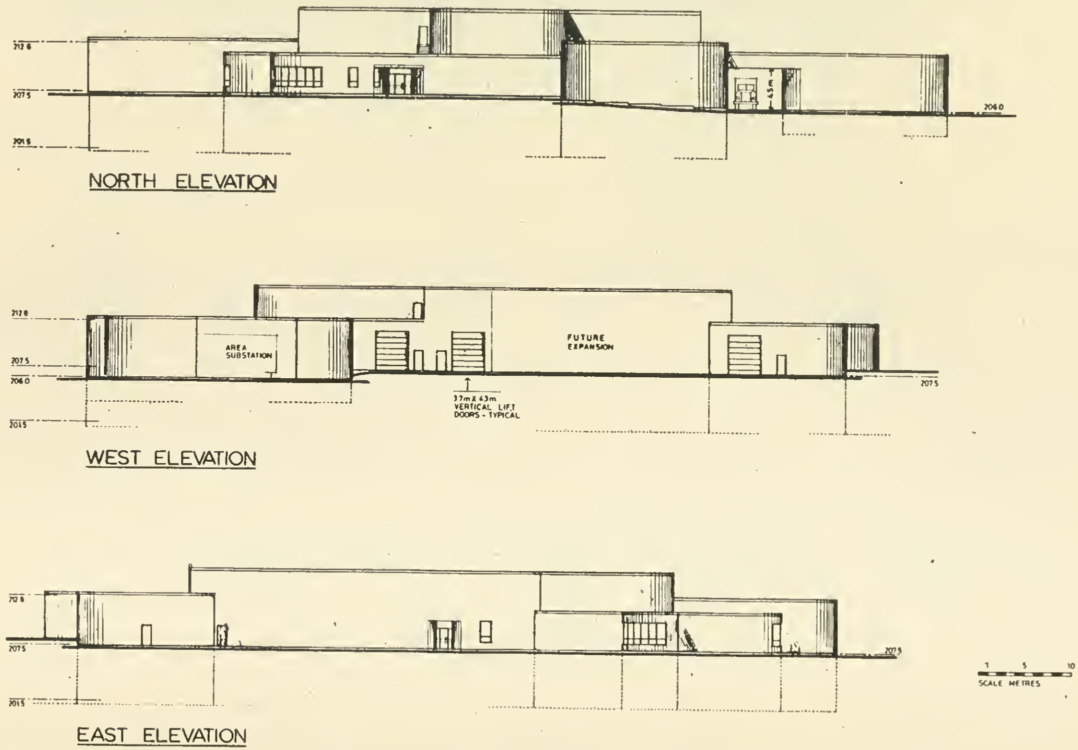
SECTION - NORTH / SOUTH



SECTION - WEST / EAST

1 5 10
SCALE METRES

ASSOCIATE ARCHITECT TOSSELL AND CAUGHILL ARCHITECT & CONSULTING ENGINEER SAULT STE MARIE ONTARIO		Sault Ste. Marie Infrastructure Program Water Treatment Plant	Proctor & Redfern Limited Consulting Engineers Toronto	
		BUILDING SECTIONS	Scale AS SHOWN Drawn by T S G Chd by C O T	Date NOVEMBER 1982 FIGURE No. 6



ASSOCIATE ARCHITECT

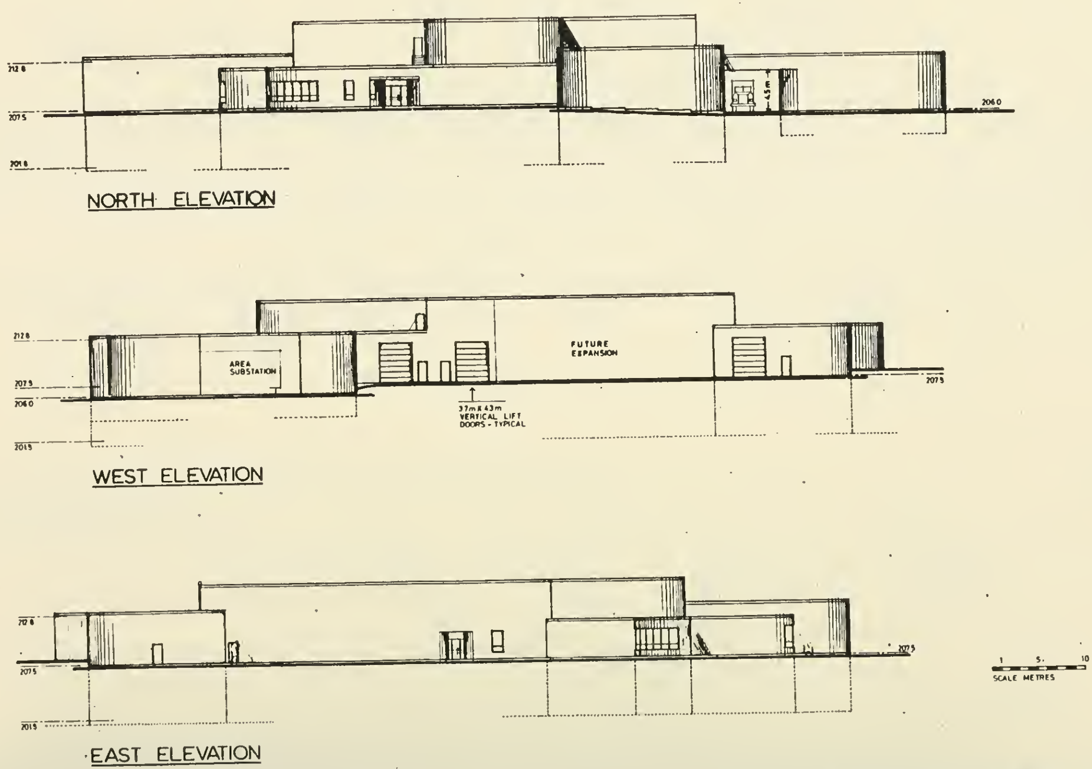
TOSSELL AND CAUGHILL
ARCHITECT & CONSULTING ENGINEER
SAULT STE MARIE ONTARIO

Sault Ste. Marie Infrastructure Program
Water Treatment Plant

BUILDING ELEVATIONS

Proctor & Redfern Limited
Consulting Engineers
Toronto Sault Ste Marie

Scale AS SHOWN
Date NOVEMBER 1982
Drawn by T.S.G.
Chk'd by C.D.T.
FIGURE No. 7



ASSOCIATE ARCHITECT

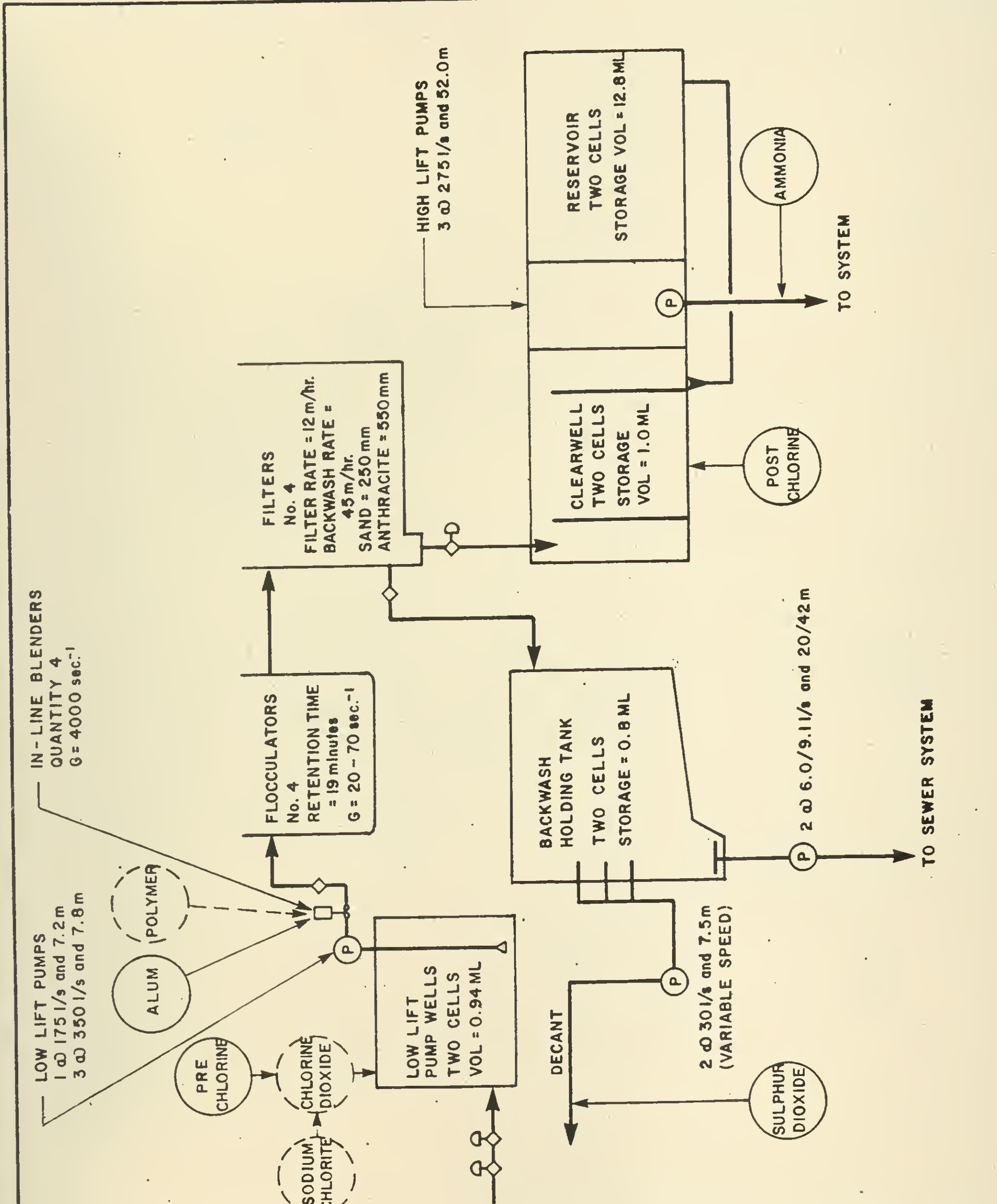
TOSSELL AND CAUGHILL
ARCHITECT & CONSULTING ENGINEER
SAULT STE MARIE ONTARIO

Sault Ste. Marie Infrastructure Program
Water Treatment Plant

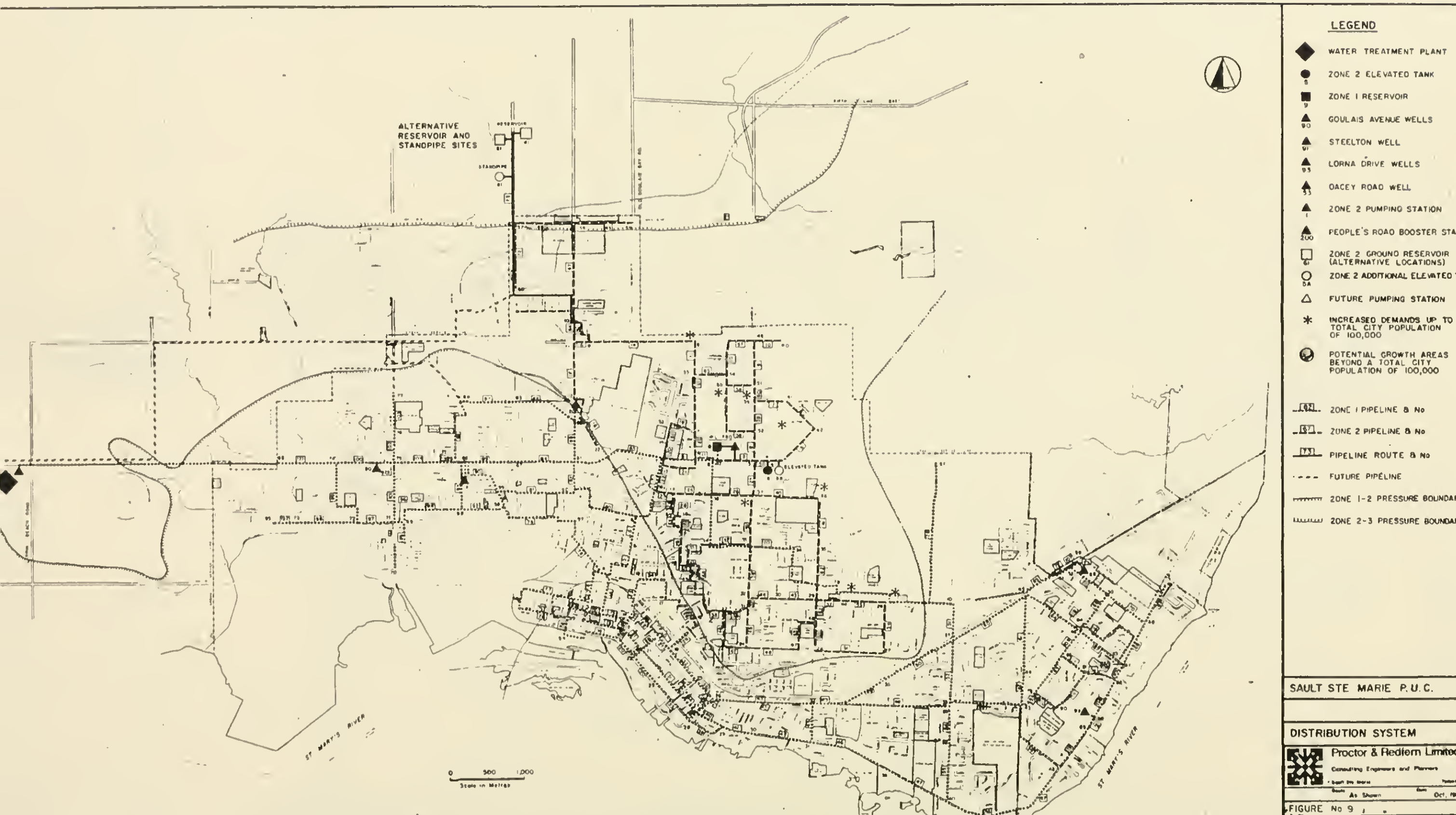
BUILDING ELEVATIONS

Proctor & Redfern Limited
Consulting Engineers
Toronto
Sault Ste Marie

Scale AS SHOWN		Date NOVEMBER 1982	
Drawn by T.S.G. Chk'd by C.D.T.	Field Book	FIGURE No 7	Rev



Drawn by	MOE OPTIMIZATION STUDY SAULT STE. MARIE WATER TREATMENT PLANT	Proctor & Redfern Limited Consulting Engineers & Architect Toronto
Ckd. by	PROCESS BLOCK DIAGRAM	Scale / Date FIGURE No. 8



LEGEND
WATER TREATMENT PLANT
ZONE 2 ELEVATED TANK
ZONE 1 RESERVOIR
GOULAIS AVENUE WELLS
STEELTON WELL
LORNA DRIVE WELLS
DACEY ROAD WELL
ZONE 2 PUMPING STATION
PEOPLE'S ROAD BOOSTER STATION
ZONE 2 GROUND RESERVOIR (ALTERNATIVE LOCATIONS)
ZONE 2 ADDITIONAL ELEVATED TANK
FUTURE PUMPING STATION
INCREASED DEMANDS UP TO TOTAL CITY POPULATION OF 100,000
POTENTIAL GROWTH AREAS BEYOND A TOTAL CITY POPULATION OF 100,000
ZONE 1 PIPELINE & No
ZONE 2 PIPELINE & No
PIPELINE ROUTE & No
FUTURE PIPELINE
ZONE 1-2 PRESSURE BOUNDARY
ZONE 2-3 PRESSURE BOUNDARY
ALTERNATIVE RESERVOIR AND STANDPIPE SITES
RESERVOIR
STANDPIPE
ELEVATED TANK
ST MARY'S RIVER
ST MARY'S RIVER
0 500 1,000
Scale in Metres
SAULT STE MARIE P.U.C.
DISTRIBUTION SYSTEM
Proctor & Redfern Limited
Consulting Engineers and Planners
As Shown
Oct. 1984
FIGURE No 9

SAULT STE. MARIE WATER TREATMENT PLANT BLOCK DIAGRAM

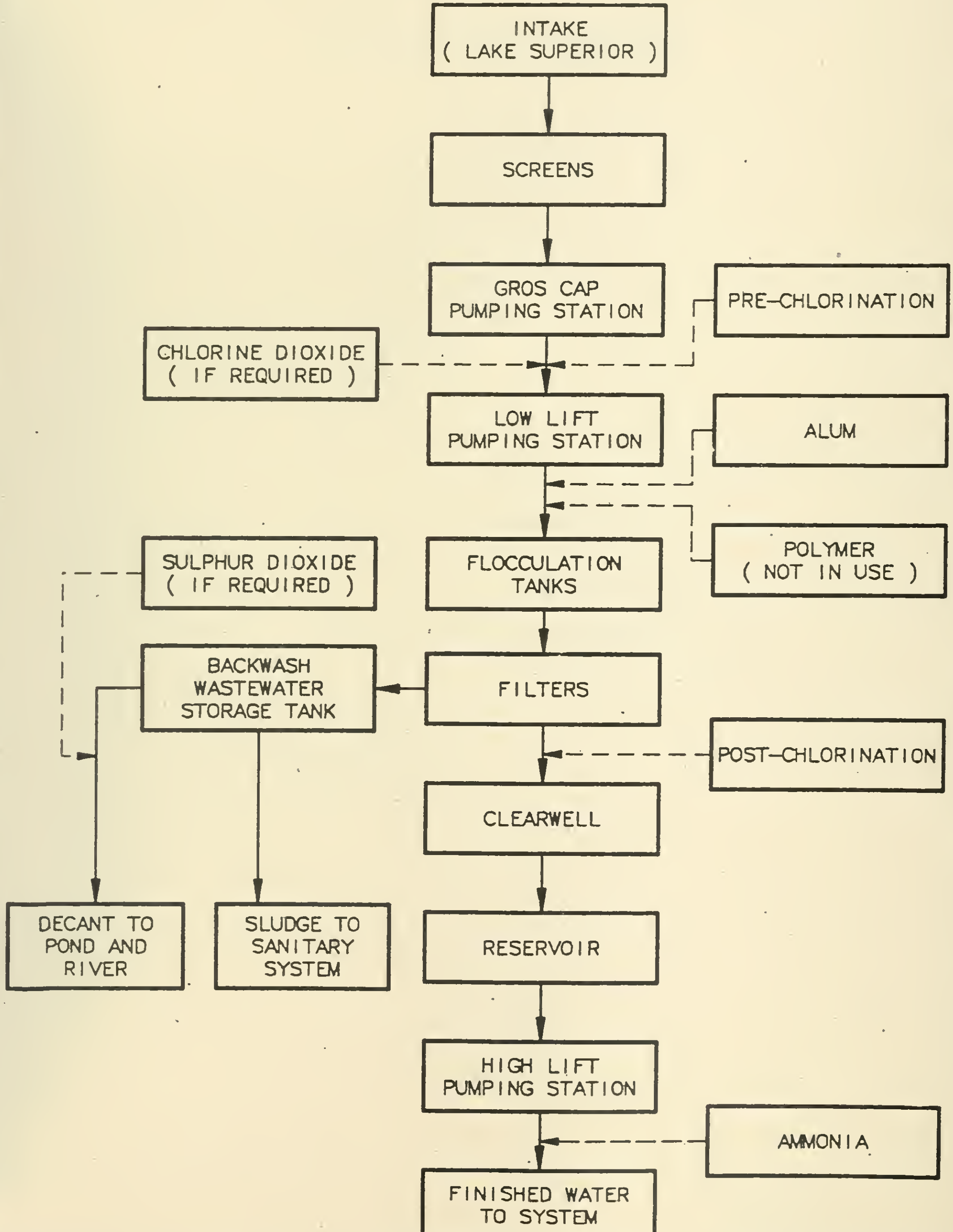


FIGURE No. 10

HOLME/procSAULT.WTP

SAULT STE. MARIE TYPICAL WELL BLOCK DIAGRAM

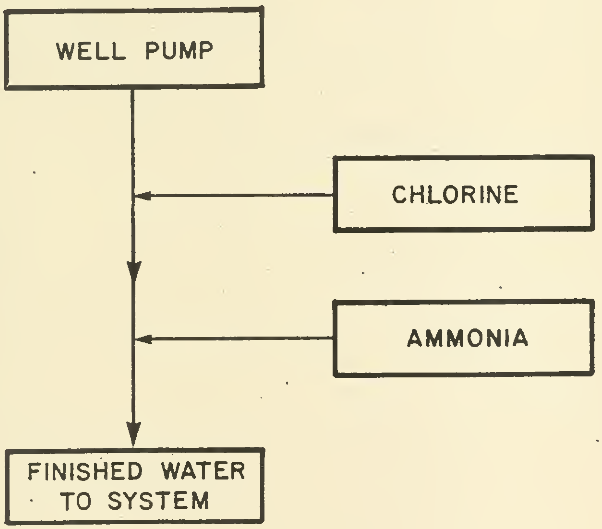


FIGURE No. 11

APPENDIX D

TERMS OF REFERENCE

WATER PLANT OPTIMIZATION STUDY
PLANT INVESTIGATION AND PROCESS EVALUATION STUDY
TERMS OF REFERENCE

Purpose

To review the present conditions and determine an optimum treatment strategy for contaminant removal at the plant, with emphasis on particulate materials and disinfection processes.

Work Tasks

1. Receive a package of available information on the plant from the MOE. Review the information provided and meet with the MOE staff to discuss the project.

2. Document the quality and quantity of raw and treated waters. Along with Work Task 3, send a progress report to the Project Committee at the conclusion of this work.

3. Define the present treatment processes and operating procedures. Along with Work Task 2, send a progress report to the Project Committee at the conclusion of this work.

4. Assess methods of efficient particulate removal which would utilize the present major capital works of the plant. Evaluate the particulate removal efficiency and sensitivity of operation, assuming optimum performance of the plant. Along with Work Task 5, send a progress report to the Project Committee at the conclusion of this work.

5. Assess methods which would improve, if necessary, the disinfection practices of the plant, keeping in mind a desire to minimize the production of chlorinated by-products in the treated water. Along with Work Task 4, send a progress report to the Project Committee at the conclusion of this work.

6. Describe possible short and long-term process modifications to obtain optimum disinfection and contaminant removal, with emphasis on particulate removal and a desire to minimize the production of chlorinated by-products. Meet with the Project Committee at the conclusion of this work to review the report information.

7. Prepare 7 copies of the draft report and submit to the Project Committee.

8. Review the Project Committee's comments and prepare 25 copies of the final report.

11/08/86

WATER PLANT OPTIMIZATION STUDY
PLANT INVESTIGATION AND PROCESS EVALUATION STUDY
TERMS OF REFERENCE - WORK TASK NO. 1

---

1. RECEIVE A PACKAGE OF AVAILABLE INFORMATION ON THE PLANT FROM THE MOE. REVIEW THE INFORMATION PROVIDED AND MEET WITH THE MOE STAFF TO DISCUSS THE PROJECT.

Elements of Work

(a) Receive a package of available information from the MOE concerning the plant.

(b) Review the information and otherwise prepare for a meeting to initiate work on the project, including preparation of a schedule of manpower and staff requirements.

(c) Meet with the MOE to discuss the available data, the terms of reference, and the project staff and work schedule.

2. DOCUMENT THE QUALITY AND QUANTITY OF RAW AND TREATED WATERS. ALONG WITH WORK TASK 3, SEND A PROGRESS REPORT TO THE PROJECT COMMITTEE AT THE CONCLUSION OF THIS WORK.

<u>Elements of Work</u>

(a) Tabulate the daily raw and treated water flows for the last three consecutive years.

(b) Document the methods of measuring the raw and treated water flow rates, and assess the validity of the records.

(c) Prepare a monthly summary of maximum, minimum, and average flows for the three years. Address any discrepancies which exist between raw and treated flow rates.

(d) Review and assess the monthly maximum, minimum, and average per capita flow for the three years. Compare the plant data with typical per capita flows for the local region.

(e) Document a summary, based on at least three years of data, of the raw and treated water quality testing data for physical, microbiological, radiological, and chemical water quality information. Document as much data as is needed to show possible seasonal trends in water quality. Where possible, show corresponding sets of raw and treated water quality information. Document the source and methods used in determining all water quality information. Assess the validity of the data, comparing plant and outside laboratory data.

(f) Tabulate, for the last three consecutive years, where available, raw and treated water turbidity, residual aluminum, pH, and colour. Record other data, such as particle counting, suspended solids, and algae counting, which could reflect on particulate removal efficiency. These data should be used for assessment of the particulate removal efficiency of the plant. Document the source and methods used in determining all information. A comparison should be made between the plant and outside laboratory information to ascertain the relative validity of the data. For plant data, emphasis should be given to plant laboratory tests rather than continuous process control instruments.

(g) Tabulate, for the last three consecutive years, the raw water bacterial test information at the plant. Also tabulate the corresponding treated water tests at the plant which register positive results. Document the source and methods used for all data provided. This information should be used to assess the effectiveness of the disinfection practices at the plant.

(h) Identify and recommend other water quality concerns, not related to particulate removal or disinfection, which should be considered as part of the assessment phase of this evaluation program.

(i) Submit a progress report to the Project Committee.

3. DEFINE THE PRESENT TREATMENT PROCESSES AND OPERATING PROCEDURES. ALONG WITH WORK TASK 2, SEND A PROGRESS REPORT TO THE PROJECT COMMITTEE AT THE CONCLUSIONS OF THIS WORK.

Elements of Work

(a) Where drawings are available, assemble sufficient record drawings, of a reduced size, to document the general site layout and the interrelationship of major plant components. If not already available, prepare a process and piping diagram (PAPD) of the plant operations.

(b) Prepare a simplified block schematic of the major plant components.

(c) Prepare a photographic record of the plant facilities, illustrating all of the major plant components and chemical feed systems.

(d) Tabulate the design parameters for all of the major plant components, with emphasis on the process operations, including chemical feeds. This information, as a minimum, must be consistent with the DWSP Questionnaire and must be confirmed and verified by field observations.

(e) Prepare a brief summary of how the plant is operated, including chemical dosage control, such as jar testing information, filter backwashing procedures and initiation, and pumping and flow control.

(f) Document and assess any reported problems in plant operations and/or in the distribution system related to water quality.

(g) Tabulate the daily average chemical dosages for the last three consecutive years. Document the methods used to evaluate chemical dosages and establish the validity of the dosage information provided.

With regard to disinfection, tabulate the dosages of chlorine and disinfection-related chemicals such as chlorine dioxide. In addition, provide corresponding data on disinfectant residuals in the plant, such as free and total chlorine residuals. Also, provide chlorine demand tests where available. Again, document the methods of dosage evaluation and residual measurements, and establish the validity of the data provided.

(h) Submit a progress report to the Project Committee.

4. ASSESS METHODS OF EFFICIENT PARTICULATE REMOVAL WHICH WOULD UTILIZE THE PRESENT MAJOR CAPITAL WORKS OF THE PLANT. EVALUATE THE PARTICULATE REMOVAL EFFICIENCY AND SENSITIVITY OF OPERATION, ASSUMING OPTIMUM PERFORMANCE OF THE PLANT. ALONG WITH WORK TASK 5, SEND A PROGRESS REPORT TO THE PROJECT COMMITTEE AT THE CONCLUSION OF THIS WORK.

Elements of Work

(a) Using information provided in Work Tasks 1 and 2, evaluate the plant's particulate removal efficiency. The basis of minimum particulate removal should be 1.0 FTU, which is the maximum acceptable concentration of the Ontario Drinking Water Objectives (Table 1, page 2, Ontario Ministry of the Environment, Revised 1983). It should, however, be recognized that it is desirable to strive for an operational level which is as low a turbidity level as is achievable.

(b) Conduct an evaluation of possible optimum performance alternatives, including jar testing of plant water samples.

(c) Evaluate the feasibility of optimum removals using the existing plant capital works. This evaluation should consider the worst case water quality conditions, even though field testing data may not be available during the initial phase of the study (see Work Task 7).

(d) Describe the operational procedures, management strategies, and equipment required for various feasible alternatives. Estimate chemical dosages, level of operational expertise, and sensitivity of operation of the alternatives.

(e) Submit a progress report to the Project Committee.

5. ASSESS METHODS WHICH WOULD IMPROVE, IF NECESSARY, THE DISINFECTIO PRACTICES OF THE PLANT, KEEPING IN MIND A DESIRE TO MINIMIZE THE PRODUCTIO OF CHLORINATED BY-PRODUCTS IN THE TREATED WATER. ALONG WITH WORK TASK 4 SEND A PROGRESS REPORT TO THE PROJECT COMMITTEE AT THE CONCLUSION OF THI WORK.

Elements of Work

(a) Using the information provided in Work Tasks 1 and 2, evaluate the plant's ability to disinfect the water. The basis of minimum disinfection shoul be to ensure a water quality as described in the Ontario Drinking Wate Objectives (Ontario Ministry of the Environment, Revised 1983).

(b) Conduct an evaluation of possible optimum disinfection procedures for th plant, with consideration also given to the reduction of chlorinate by-products in the treated water.

(c) Evaluate the feasibility of the various alternatives using the existin plant capital works. Estimate the initial and final levels of chlorinate by-products for the various alternatives. Assess the relative merits o the alternatives.

(d) Describe the operational procedures, management strategies, and equipmen required for the feasible alternatives. Estimate chemical dosages, leve of operational expertise, and sensitivity of operation for th alternatives.

(e) Submit a progress report to the Project Committee.

6. DESCRIBE POSSIBLE SHORT AND LONG-TERM PROCESS MODIFICATIONS TO OBTAIN OPTIMUM DISINFECTION AND CONTAMINANT REMOVAL, WITH EMPHASIS ON PARTICULATE REMOVAL AND A DESIRE TO MINIMIZE THE PRODUCTION OF CHLORINATED BY-PRODUCTS. MEET WITH THE PROJECT COMMITTEE AT THE CONCLUSION OF THIS WORK TO REVIEW THE REPORT INFORMATION.

Elements of Work

(a) It is not the purpose of this study to provide a detailed implementation scheme for plant rehabilitation. It is, however, necessary to scope the feasible short and long-term process modifications required to achieve optimum disinfection and contaminant removals.

Prepare a list of modifications which should be considered for detailed implementation evaluation. Provide an estimated cost for each of the proposed modifications.

(b) Prepare a schedule for the list of modifications.

(c) Meet with the Project Committee at the plant site to review the proposed modifications.

7. PREPARE 7 COPIES OF THE DRAFT REPORT AND SUBMIT TO THE PROJECT COMMITTEE.

Elements of Work

(a) The report must include all the information reported previously in the study. The information must be organized and presented in a logical and co-ordinated fashion.

A general table of contents will be provided for organizing the material in a manner consistent with other plant reports.

(b) Submit the draft report to the Project Committee for review.

(c) Prepare a separate letter report containing a recommendation(s) concerning the need for additional field testing to cover water quality conditions not available during the period of this study. The Project Committee may decide to delay completion of the final report until field data can be obtained to confirm the predictions of performance for the worst case water conditions.

8. REVIEW THE PROJECT COMMITTEE'S COMMENTS AND PREPARE 25 COPIES OF THE FINAL REPORT.

Elements of Work

(a) Conduct additional field testing if required. Discuss the implications of the results with the Project Committee if the results differ from the predicted performance.

(b) Amend the report as per review comments, incorporating additional field data if required.

(c) Submit copies of the final reports to the MOE for distribution.